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A compromise plan for elevating the tracks of the Pittsburg, Fort Wayne & Chicago and the Chicago & Western Indiana railways in Chicago has been submitted by Mr. Geo. H. Ellers, Consulting Engineer to the Mayor. The plan submitted to the city by the Pennsylvania company, some time ago, provided for a maximum elevation of the tracks of 8 ft., with the depression of all intersecting streets, the closing of 51st St., and the construction of a viaduct at 52d St. This plan Mr. Ellers proposes to follow in the main, but including the tracks of the Chicago & Western Indiana R. R. in the same plan. The tracks of both roads will be elevated to a height of 10 ft. from the south branch of the Chicago River to 70th St., with such occasional descents from this elevation as may be necessary to avoid existing obstacles. The maximum grade will be 1%. The plans call for the construction of over 30 subways and viaducts at the intersections of the various streets, and other railway lines. We hope to give a full description of the plans in a future issue.

The laying of a large submerged sewer outlet is now being completed in connection with the Massachusetts metropolitan sewerage system, which serves a part of Boston and many surrounding municipalities. The crossing is beneath Shirley Gut, where there is 18 ft. of water at low tide for a short distance, and, it is said, the water runs more swiftly than at any other place in Boston Harbor. The water has a total width of perhaps 400 ft., but is shallow at each shore. A ⅝-in. single riveted steel tube with flange joints, each of which is secured by 40 1-in. bolts, will be lined with three rings, or 13 ins., of brick masonry to form an inverted siphon, with an internal diameter of between 5 and 6 ft. The siphon is placed in a comparatively shallow trench, and the steel tube is principally intended as a protection to the brickwork. The pipe was laid in three sections, the last of which, after having been bolted together on the shore, was towed and sunk into place Sept. 23. On Sept. 30 the writer found the divers making good the last joints. There will be a manhole at each end of the pipe. A row of sheet piling, of timbers 8 ins. square, was driven across the gut to break the force of the current during the work. Mr. Howard A. Carson is the Chief Engineer of the Metropolitan Sewerage Commissioners.

The Holland submarine boat described in our issue of Sept. 21 has been recommended to the Navy Department by the board appointed to examine and report upon the various designs of submarine boats submitted. An appropriation of $200,000 is available, and the board recommends that the Holland Co. be instructed to have a boat built by some responsible contractor, and that the contract be awarded to the Holland Co. at the price asked by it, $135,000.

So many steam heated cars are now run on the Pennsylvania R. R. that a system of piping for heating cars while standing is being put in place between the tracks of the new Broad St. station in Philadelphia.

A 39-ton spool, containing 18,430 ft. of 1½-in. steel cable for the Third Ave. railway in this city, was recently transported on timbers and rollers from the wharf, at 64th St. and East River, to the powerhouse. The 10 wooden rollers, 10 ins. in diameter, ran on heavy planks, and several heavy timbers on top of the rollers carried the spool. It was hauled up a pretty steep hill and along the streets by hawsers and a horse capstan, large posts being sunk in the line of travel for anchors. A second cable, weighing probably 59 tons, will soon be delivered for the downtown station; and this one, says Contractor Joyce, will be hauled by horses on his large truck which is to have wheels 3 ft. in diameter and tires 24 ins. wide.

Good progress is being made by the Massachusetts State Board of Health in its investigations for a metropolitan water supply system for Boston and the surrounding municipalities within a radius of ten miles. Of course it will be many years before any broad scheme can be carried out. Meanwhile the city of Boston is considering the filtration of its Mystic supply. The cost of the necessary filter beds has been estimated at from $500,000 to $550,000. Whatever the outcome of the metropolitan water supply investigations, of course no good water supplies in the district will be abandoned for the new supply, while some municipalities outside the ten-mile limit are likely to come in. Mr. F. P. Stearns, M. Am. Soc. C. E., is Chief Engineer of the Massachusetts State Board of Health and since the above investigations were begun Mr. A. F. Noyes, M. Am. Soc. C. E., formerly City Engineer of Newton, Mass., has been associated with Mr. Stearns.

The most serious railway accident of the week may be again credited to the unlucky "Big Four." It was a collision which occurred at 5 a. m., Oct. 2, at Edgemont, O. A fast freight train ran into three loaded cars which a switch engine's crew had carelessly left on the main track when the freight was due. Three tramps were killed in the wreck.——An accident with the same number of fatalities occurred on the Knoxville branch of the Louisville & Nashville near Hazel Patch, Ky., on Sept. 28. A collision occurred between a passenger train and a mixed freight due to the passenger engineer disobeying his orders to wait for the freight.——Three trains were wrecked by train wreckers this week, in two cases by opening a switch at a little used side track, and in each of these cases two lives were lost in the wreck. These accidents occurred on the Louisville & Nashville at Gulfport, Miss., Sept. 28, and on the St. Louis & San Francisco at Lyman, Mo., Oct. 1. The third case of train wrecking was near Sedalia, Mo., on the Lexington branch of the Missouri Pacific, Sept. 27. A tie was fastened in a trestle with its end projecting above the rails. The engine and tender were wrecked, but its crew escaped with slight injuries.——A rear collision occurred on the Chicago & Grand Trunk Ry., Sept. 27, between two fast express trains. A private car at the rear of the head train was telescoped and two persons were killd.

A bridge on the Great Northern Ry. near Snohomish, Wash., collapsed while a work train was crossing on Sept. 26. The wreck is supposed to have been caused by a pile driver car at the rear of the train striking some part of the bridge structure.——Many bridges have been washed away in the Texas panhandle by heavy floods.——Two falls of highway bridges are reported, one at Laona, N. Y., Sept. 30, and one at Kinsman, O., on the same day. In each case the collapse occurred under a two-horse wagon loaded with stone, and the load, team and driver went down with the bridge, and in each case the driver escaped with a few bruises.——A freight train on the Kansas City, Wyandotte & Northwestern Ry. broke through a bridge at Valley Falls, Kan., Sept. 12.

The Mott Haven station building, of the N. Y. C. R. R. at 138th St., in this city, has just been moved back nearly 50 ft. from its original foundations to make room for new tracks. The building is 200 ft. long by 40 ft. wide; is built of brick and weighs about 2,000 tons. A square tower of brickwork is alone estimated at 500 tons. The work is being done by Mr. B. C. Miller, of Brooklyn, and after the ways were placed in position the building was moved by 30-ton jackscrews at the rate of from 7 to 10 ft. per day, without cracking the brickwork. The floors have all been removed and the interior is thoroughly braced by wood, iron and cables. This is claimed to be one of the largest brick structures ever moved in this way.

By the cave-in of the Mansfield Mine in the Crystal Falls, Mich., mining district, the Michigamme River was given an entrance to the working chambers and 28 miners were drowned. The mine inspector claims that the timbering was properly done, and that the disaster proves that timber supports are not a safe reliance in such material as was encountered at Mansfield.

A great storm on the Gulf coast, Oct. 2, is believed to have caused damage and loss of life second only to that wrought on the Sea Islands by the storm of Aug. 27 last.

The patent suit of the Union Switch & Signal Co. against the Johnson R. R. Signal Co. for infringement of patents on signal selectors held by the plaintiff was decided on Sept. 26 in favor of the Johnson Co. by Judge Greene, in the U. S. Circuit Court, District of New Jersey. The defendant's contention was that its signal selector was not an infringement, and was covered by patents granted to Mr. Henry Johnson. Mr. J. Snowden Bell was the plaintiff's counsel, and Messrs. Edwin H. Brown, Geo. W. Miller and Edward L. Savage conducted the defense.

Another decision in a signal suit was handed down by Judge Acheson, at Pittsburg, Oct. 2. In this case the Johnson Co. sued the Union Co. for infringement of the Sykes patents. According to the press report, the patents were owned by Mr. Frederick Cheesright, who made a Mr. Yeomans his agent for handling the U. S. patent on a royalty basis. Mr. Yeomans sold the exclusive right to the use of the patents to the Union Switch & Signal Co., in March, 1882, an act which Judge Acheson holds was void without the concurrence of the principal. Mr. Cheesright then sold his patents to the Johnson Co., and this is held to be the lawful sale, and the Johnson Co. is entitled to an injunction against infringers.

The 1,150-ft. tower now being erected at Wembley Park, near Sudbury Station, on the London & Northwestern Railway, has reached a height of 62 ft. Sir Edward Watkin, the promoter of the scheme, invited plans for this tower three years ago, and finally accepted one from Mr. A. D. Stewart very like the Eiffel tower in general design, except that the elevators will ascend vertically from the center of the base. The tower will stand on four groups of four legs each, resting on 16 separate concrete foundations put in about one year ago. Messrs. Heenan & Froude, Manchester, are the contractors for all above the foundation level, including the elevators, of which there will be four, two ascending to the height of 150 ft. and two to a height of 900 ft. The extreme width of the base of the tower, from outside to outside of legs, is 406 ft., and the height exceeds that of the Eiffel tower by 150 ft. Mr. W. Gilbert is engineer for the Tower Company and Sir Benjamin Baker is consulting engineer.

The Trans-Caspian Ry. is to have a new branch extending from Mulla Kara to Krosnovodsk, says the "Journal de St. Petersbourg," and the sum of 5,000,000 roubles has been set aside for its construction by the Russian War Minister. The same journal says that the extension of the Trans-Caspian from Samarkand to Tashkend is again under consideration. The line would run from Samarkand to Brigovatt, on the Oxus, and would there branch to Ferghana and to Taskkend.

A sewage pumping plant, with four pumps each of 15,000,000 gallons capacity daily, has been erected for Bombay by Messrs. James Simpson & Co. The sewage is lifted 30 ft. As described in "The Indian Engineer," each horizontal pump has three steam cylinders of 11, 17 and 29 ins., with steam admitted at 75 lbs. pressure. Each plunger is 3 ft. in diameter with 3-ft. stroke. The capacity of the four pumps, in 24 hours, is said to be 60,000,000 gallons, or 17,857 tons, lifted 30 ft.

It is proposed, says "Herepath's Journal," to combine the whole coal business of the United Kingdom into a limited liability company, with a capital of $550,000,000, to some degree under the control of the English Board of Trade. Only such prices are to be charged for coal as would pay 5% on the debentures and 15% on the shares. "Herepath" does not regard the scheme as feasible nor desirable. The Salt Union is the one solitary monopoly of recent times in England.

The census of India for 1891 shows a total population of 287,223,431, an average of 184 per square mile. The population of the British provinces is 221,172,952, or 77% of the population on 61.85% of the total area. Out of a total of 2,085 towns 1,401 have less than 10,000 inhabitants. Bombay has a population of 821,764, and Calcutta comes next with 741,144. The Census Commissioner, in his report to the House of Commons, says that the final enumeration of 250 millions of people was carried out within four hours.

MORE WATER WANTED FOR PHILADELPHIA.

In a recent communication to the Mayor of Philadelphia, Director of Works Windrim points out the urgent need of an increased water supply for that city. Mr. Windrim says that during the summer just past the average daily pumpage was 196,000,000 gallons; and though this is a daily average of 163 gallons per head on an estimated population of 1,200,000, there were many complaints of a scarcity of water and low pressure. Notwithstanding this heavy pumpage, which at times actually equalled the flow in the Schuylkill River, the storage in the East Park reservoir fell for a time at the rate of 4 ins. per day in water surface.

Mr. Windrim, from the various reports and statistics on hand concerning an increase in water supply, recommends that the present system be supplemented by the construction of storage dams on the Perkiomen and Tohickon creeks, and that the waters of these streams be conveyed by gravity into the Queen Lane and East Park reservoirs and thence to the lower reservoirs. He thinks this will be the cheapest and most direct plan for providing an auxiliary to the present Schuylkill supply. It will serve for the near future and may be used as the beginning of a system that may be extended to the mountain streams as the requirements of the city further demand.

This plan proposes the utilization at once of about 227.2 square miles of the watersheds of the Perkiomen and Tohickon creeks, which will give an available flow of 209,000,000 gallons daily. Including the aqueduct, the total cost of this system would be about $19,000,000, and the system can be extended so as to impound other streams and provide for the full capacity of the aqueduct, or 310,000,000 gallons per day. The first work would be to build a dam above Green Lane, on the Perkiomen, and others higher on that stream; also to build an aqueduct capable of conveying this water and that from the Tohickon and other streams, to the amount of 310,000,000 gallons daily. The estimated first cost is divided as follows: For reservoirs, $3,200,000; for aqueduct, $11,500,000; total, $14,700,000. The supplemental work called for by the erection of additional storage dams on the Tohickon and other streams would add $4,800,000 to the above sum.

This plan is similar to that presented by Mr. H. P. M. Birkinbine, when Chief of the Water Department, in 1865, and was then put aside on account of its cost. This general plan has also been indorsed by the commissioners appointed to report on a future water supply for Philadelphia, while the location of the dams and aqueduct was more particularly described and recommended by Mr. James F. Smith, Chief Engineer of the Schuylkill Navigation Co. The flow of the Schuylkill River, after deducting that of the Perkiomen Creek above Green Lane, would still be available for navigation, and for the present pumping stations, as the water stored is practically that which would otherwise pass down the river in freshets unutilized.

Mr. Windrim says that if councils should favorably consider the suggestions made it would require from four to six months to prepare the necessary trial plans, soundings and engineering work before the plans could be made upon which bids could be invited. After that the progress of the work would depend upon the appropriations made by Councils. The aqueduct would be about 27½ miles long and could be let in two-mile sections. On an appropriation of $4,000,000, five sections of the conduit could be first contracted for, and the remaining conduit and reservoir could be provided for later.

The following table is added, giving the average annual flow of sundry streams from Oct. 1, 1891, to Oct. 1, 1892:

Watersheds.	Area in miles.	Average annual yield in gallons.	Average daily yield in gallons.
Perkiomen, at Frederick, 9 years.....	152.0	67,633,235,876	185,254,855
Neshaminy, below Forks, 9 years....	139.3	57,876,291,585	158,543,534
Tohickon, 9 years..	102.2	51,573,780,403	149,244,444
Sudbury, Mass., 16 years	75.2	29,616,392,000	81,140,800
Croton, New York, 17 years	338.0	135,400,000,000	371,600,000

The following summary of the capacity and cost of the system follows a table of the detailed cost and capacity of the several storage reservoirs proposed: Total watershed area, 227.2 square miles; total available flow, 209,000,000 gallons per day; total storage capacity, cubic feet, 8,527,185,530; gallons, 63,783,275,764; total cost of reservoirs, $7,839,518; average cost per million gallons stored, $122.91; area of Tohickon watershed, 73.1 square miles; available flow of Tohickon Creek, 71,000,000 gallons per day.

PAPERS ON SURVEYING AT THE INTERNATIONAL ENGINEERING CONGRESS.

Four papers on surveying were presented at the recent International Engineering Congress, but with one exception they contain little of interest to the practicing engineer or surveyor. Two of the four, "Military Surveys and Reconnaissance and Map Duplication in the Field" and "Military Sketching and Maps," were read before the division of Military Engineering by Lieut. Henry Jervey, Corps of Engineers U. S. Army, and Col. Von Usedom, of the Royal Prussian Government Survey.

The first mentioned paper discussed briefly: (1) The principles and methods of obtaining and recording topographical information for military purposes, and (2) the best methods of duplicating maps in the field. The second paper, by Col. Von Usedom, treats concisely of the principles to be observed in sketching for military maps and the best systems of delineating topography.

The other two papers were read before the Civil Engineering division and will be published in the Am. Soc. C. E. "Transactions." One was by Mr. H. D. Hoskold, Director of the Department of Mines and Geology, Argentine Republic, entitled "Historical Notes Upon Ancient and Modern Surveying and Surveying Instruments." The title indicates pretty clearly the character of the contents.

The other paper was upon "Topographic Surveys," by Mr. Herbert A. Ogden, of the U. S. Coast and Geodetic Survey. It discussed briefly the methods of foreign topographic surveys and described quite fully the various topographic surveys in the United States. The main topographic survey in this country is the well known Geological Survey, established in 1878. The Coast Survey also covers the topography of the territory immediately bordering the sea coast. In speaking of these the author states that the chief essential in securing uniform work is an established criterion to gage the efficiency of the work. Such a criterion was formulated about a year ago by a conference of topographers assembled in Washington, D. C., as follows: All topographic work is to be based upon computed triangulation. The scale should be 1 : 30,000 except on mountain tops and flat areas with little natural detail, where the scale of 1 : 40,000 is recommended. In considering types for interior work New England was selected as representing the greatest variety of natural and artificial detail. Rules for this type were prepared and were taken as a basis for all other types, receiving such additions or modifications as were found desirable. A general topographic survey should show hills, valleys, plains, waterways, settlements and domiciles. These may be subdivided in ways that will naturally suggest themselves. For the New England States the contour interval was taken at 20 ft. The heights of hills are to be given within 5 ft.

The cost of topographic surveys vary, of course, with the amount of detail. The average cost of the Ordnance Survey of Great Britain on a scale of 1 : 25,000 is $186 per sq. mile. In Germany the cost is $79 and in Austria about $400 per sq. mile on the same scale. In India the costs on scales of 1 in., 2 ins. and 6 ins. to the mile were $11, $26 and $400 per sq. mile, respectively. In the United States the geological survey of Massachusetts, Connecticut and Rhode Island has cost $13, $9.80 and $9 per sq. mile, respectively. The topographic work of the Mississippi River Commission cost for hydrographic work $48 per sq. mile, and the topographic work of the Coast Survey and the Survey of the Great Lakes, involving many intricate details, cost on an average $151 per sq. mile. It is probable that the survey of the whole United States on scales of 1 : 30,000 and 1 : 40,000 could be conducted on the rules laid down by the conference before mentioned at an average cost of from $35 to $45 per sq. mile.

Probably the most important advances which have been made in topographic surveying in this country have been improvements in the methods of using the plane table. The first of these was the development of the graphic method of finding a position from three other determined positions known as the three-point problem. Another advance was in substituting contour lines for hachures to indicate differences in level. The method of topographic work on the Coast Survey has now reached a development that requires only experience on the part of the topographers to produce results sufficiently accurate for all the ordinary purposes of a topographic survey.

In connection with the four papers treating exclusively of surveying, a paper by Mr. F. Stebben, of Cologne, Germany, discussing the principles to be observed in laying out cities may properly be mentioned. The practical principles to be observed in this work are summarized by the author as follows:

1. The city traffic demands the laying out of radial, ring, diagonal and by streets, as well as business squares and focal points. A mere rectangular system is unfit for a street plan. The laying out of the street roads is to be regarded. The profile of the streets should be the flattest possible, but drained, the embankments not to be too high. Excavations are to be avoided. The width and cross-section of streets should answer generously to the amount and kind of traffic. The layout of the city must also have a care for traffic not done on the streets (railway and waterway traffic).

2. The blocks formed by the network of business streets are suitable for city construction. Sharp angle corners are to be rounded off. Within the blocks the property lines are to be swung into rectangular position by either voluntary exchange or legal compulsion. The layout of the city has to provide blocks of different sizes in suitable places, such as are requisite for business operations, private houses, rented houses, stores and workmen's dwellings. Also blocks and parts of blocks to be provided in suitable size and place for erecting public buildings.

3. For reasons of health the city ground must be free from overflow or protected; the soil must be kept dry and clean. An underground system of sewers is indispensable to the removing of atmospheric precipitates, the domestic and industrial waste water and human excreta. Generous provision of good drinking water is necessary.

A sufficient provision of atmospheric light and of direct sunlight is to be served by a judicious orientation of the streets toward the cardinal points and a generous width of the streets; but, better still, by a rational arrangement of the habitations within the blocks. For night lighting the electric light is preferable to gas. The providing of the city with fresh air requires, besides sufficient width of streets and size of yards, open squares in the street system and gardens in the building blocks; such further districts as will allow only separate buildings to be erected; and, finally, shade trees on the streets, squares and separate parks. The plantations, consisting of rows of trees and garden levels, serve not merely to purify the air, but cause the city population to take bodily exercise and afford recreation and refreshment. The city layout should provide special districts for industries injurious to health or annoying in other respects.

THE EVERETT & MONTE CRISTO RAILWAY.

By. S. B. Fisher, Chief Engineer.

Owing to the nature of the country and the habits of the people, railway building in the Puget Sound country and the Cascade Mountains is generally slow, difficult and expensive. It is doubtful whether any other quarter of the habitable globe can exceed the section of country lying between the Cascade Mountains and the Coast Range and north of the Columbia River, in Washington, known as the Puget Sound country, in the variety of its weather. The annual rainfall is from 60 ins. to 120 ins. Everything which one would expect to meet in a year is crowded into a day—clouds, high winds, snow, sunshine, sleet, "chinook," rain, mist, cold. Every describable and indescribable kind of weather comes and goes with a rapidity that baffles record. On the slope of the Cascades the country is rude, savage and almost wholly undeveloped. The streams course rapidly down the mountain slopes, but in the lower parts of their courses are more quiet and can be navigated by small craft during a large part of the year. The principal streams are the Puyallup, Black, Snohomish, Pilchuck, Stillaguamish, Sauk and Skagit.

The whole country is covered with timber, principally spruce, fir, hemlock, cedar, cottonwood and alder, and there is an infinite number of prostrate trunks and a dense underbrush. From 10 ft. to 100 ft. is the ordinary range of vision, and the rate of travel is about ½ mile per hour, and about the hardest traveling a man ever attempted. Fortunately, large animal life is scarce, and the bugs and flies are generally without ferocity.

like quartz in color. The outward parts of the rocks are usually decomposed for a few feet. When the lower portions of the slopes were removed great landslides developed. These slides came down sometimes with little warning, sometimes with none, but generally gave notice by the crumbling and rolling down of small fragments from the slopes. There were over 50 of them in the canyon varying from 4 cu. yds. to over 15,000

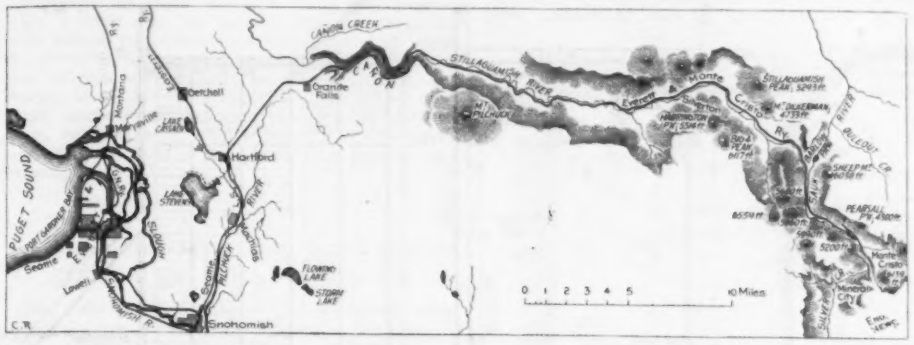


FIG. 1. MAP OF THE EVERETT & MONTE CRISTO RY., WASHINGTON. S. B. Fisher, Chief Engineer.

The Everett & Monte Cristo Ry. was projected to open up the Monte Cristo gold mines, discovered in 1889. It starts from the new city of Everett, Wash., on Puget Sound, goes up the Snohomish River to Snohomish, thence eight miles over the Seattle, Lake Shore & Eastern Ry., to Hartford Junction, thence up the valleys of the Pilchuck, Stillaguamish and Sauk rivers to Monte Cristo (Fig. 1). The general features of most of the road are such as are common to mountain roads. The maximum curvature is 13° and the maximum grade is 3% compensated at the rate of .00333 per degree. Transition curves 140 ft. and 200 ft. long are used.

Late in 1891 a preliminary survey was made, hurried through by the falling snows and approaching winter. Location was begun Feb. 20, 1892, under the direction of J. Q. Barlow. One party was started at the foot and another at the head of the canyon of the Stillaguamish River, about six miles apart. It took them six weeks' of hard work to connect the location at a middle point, thus averaging ½ mile per week per party. Some days only 100 ft. were located. In some places the men hung on by ropes, at others by the underbrush, and some parts of the line were inaccessible, points on them being located by triangulation. The location in the canyon being completed, it was continued toward Monte Cristo, following the retreating snow, which it overtook in May. The party spent about three weeks shoveling snow on the trail. The snow line in winter comes down usually to an elevation of about 600 ft. and retreats to about 5,000 ft. in summer. The snow in this region never freezes. It is loose for a day or so after falling, but soon becomes compacted. The weather is rarely cold enough to make ice. Location was completed to Monte Cristo during July, 1892.

The most interesting part of the construction was in the canyon. The lower two miles gave very little trouble, as the material stood fairly well, excepting for a few hundred feet through clay, which was as usual annoying and expensive. The middle section of the canyon is composed of a peculiar rock. When blasted it breaks up in very small fragments, nine-tenths of it too small for riprap. The seams are of clay and a soft white material

cu. yds. in volume. The material in these was much pulverized in coming down.

There are six tunnels in the canyon, all through projecting spurs (Fig. 2). No especial difficulties were met in driving these with the exception of tunnel No. 2. The principal dimensions of each and progress of work are shown in the following table:

No. of tunnel.	Length, ft.	Work begun, 1892.	Tunnel finished, 1892.	Time, days	Av. prog. p. day. ft.	No. M ft. B. M. in lining.
1	817	May 7	Nov. 9	186	4.39	276.8
2	138	July 18	Nov. 12	117	1.18	87.4
3	260	June 10	Oct. 20	131	1.97	109.
4	149	July 11	Nov 6	118	1.26	77.8
5	81	Aug. 22	Nov. 3	73	1.11	42
6	278	June 30	Oct. 8	100	2.76	60.8

All the tunnels are timbered with the exception of the middle portions of Nos. 1 and 6. The character of the timbering for the different materials penetrated is shown in Figs. 3, 4 and 5. For the sections in earth the excavation was 16 cu. yds. per lin. ft., and for the rock section 13¼ cu. yds. per lin. ft. A small air compressor was used in the east end of tunnel No. 1, running two Ingersoll-Sergeant drills; but all the other tunnels were driven by hand.

Tunnel No. 2, with which some trouble was experienced, as noted above, is on a 12° curve. It was at first thought to be a very favorable place for a tunnel, with hard rock and overlying sand. It was desired to work this tunnel from the west, principally on account of the disposition of the material, but when ready to face up for going under, the rock commenced dipping, leaving the heading partly in rock and partly in sand. Meanwhile the cut was carried further into the spur, and work was carried on from the east until the middle of September, when the eastern heading struck sand, which poured into the tunnel and could not be stopped. It now appeared that the line of the tunnel ran into an old crevice, which had since filled with sand and water-worn material, and it was determined to take the remaining distance, 107 ft., out as an open cut. A very large portion of this was taken out from the heading of the tunnel at the east end. This open cut was not completed until February, 1893.

Another point of some interest beside the canyon was tunnel No. 7. The stratum through which this tunnel was attempted to be driven is a sort of a mixture of sand and clay. At first when going under, it seemed to be firm, and remained so for several hours, being liable to flake off, however, at any time without giving notice. As the tunnel was driven it remained dry for some distance; but the sand settling down on the lining seemed to loosen up the overlying material and soon water began dripping through. When in about 150 ft. from the west end, a considerable stream of water was encountered, which was stopped with some difficulty. At a little over 200 ft., after several days' rain, the tunnel showed signs of weakness. It had been timbered with hemlock, the only timber in the vicinity. This hemlock is a pulpy wood, and under the pressure the wall plates, originally 12×12 ins., were pressed down to 4 ins. thick in places. A crown beam 12×12 ins. was placed longitudinally under the middle segments with supporting posts as the tunnel was driven. The timbering was 2 ft. between centers. As this did not seem to be strong enough, it was determined to timber solid.

Before these timbers could be introduced, however, the lining failed, being forced in just back of the breast wall. The failure occurred very suddenly one morning and the material rushed in, filling the whole tunnel up to the spring line, for a dis-

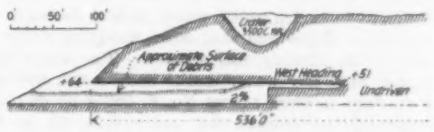


Fig. 6. Diagram Showing Cave In of Tunnel 7.

tance of over 200 ft., and being forced out 190 ft. beyond the portal (Fig. 6). Boulders of a yard or more were carried through. A crater was left in the surface of the ground some 75 ft. across and 40 ft. deep having a volume of 3,500 cu. yds. This crater subsequently partially filled with water. It is supposed by the writer that this freak was caused by hydraulic pressure in some way, as no ordinary conditions would cause a portion of the earth to convert itself into a gigantic sausage mill in this manner.

As it was impossible to rebuild this tunnel after the disaster within the time specified for completing the road, a temporary line, was built around it using 18° and 24° curves. The line has been operated with these now for some months during

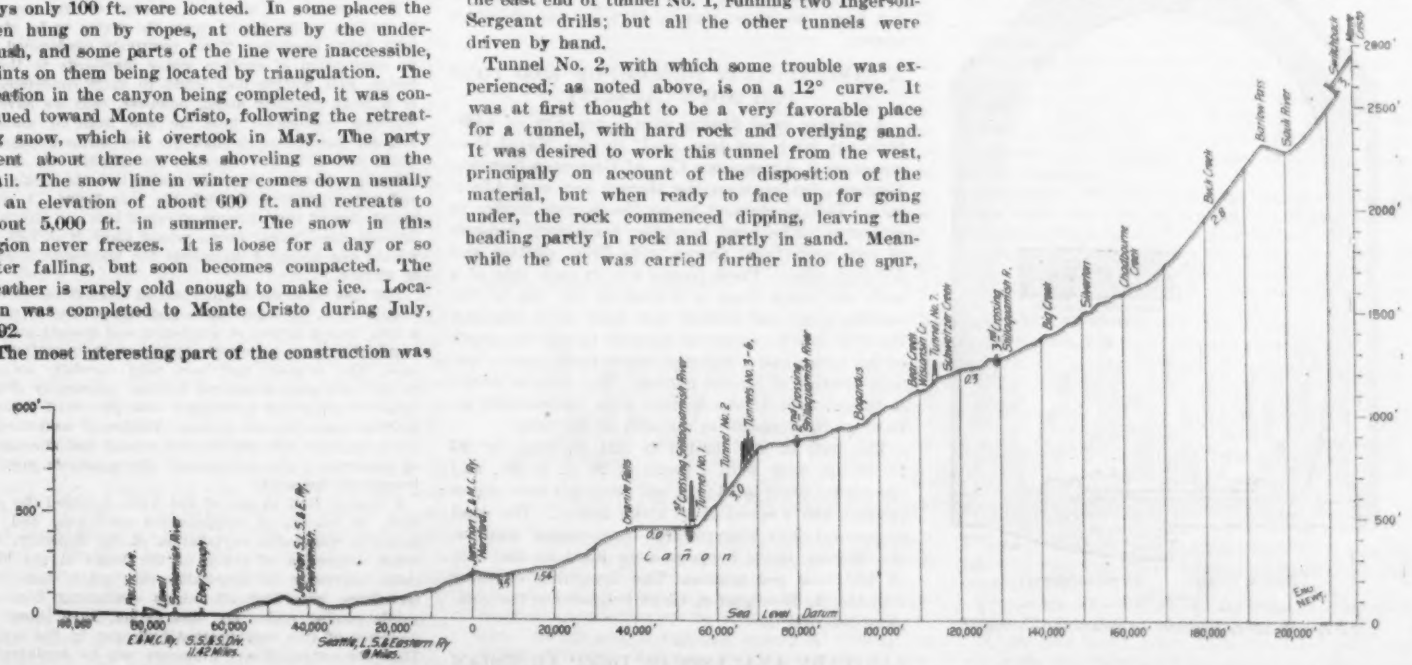


FIG. 2. GENERAL PROFILE OF THE EVERETT & MONTE CRISTO RY.

construction, using a single guard rail and plenty of rail braces. The tunnel is now being reconstructed with the masonry lining, shown in Fig. 7.

As an example of the weather which the line may be called upon to withstand, and the difficulties of the work, may be mentioned the storm which occurred about the middle of November, 1892. After a spell of good weather we had rain for a week, growing heavier each successive day. Snow fell on the upper part of line, 3½ ft. deep at Monte Cristo. On Nov. 17 the heaviest rain of all was followed by a "chinook" which melted the snow on the upper slopes and sent down floods of water on top of the already full streams. The water rose higher than any water marks had shown, and ran 4 ft. deep through tunnel No. 6, doing no damage, however, but scoured out every rock fill in the canyon which the current struck. During this flood great boulders were carried down and tossed about the canyon, striking against one another and the sides of the canyon grinding, grating, clashing with a noise almost deafening.

This storm proved that while the rock fills would resist the side current, they would not stand the direct impact of the flood. As fully nine-tenths of the line through the canyon is solid rock, there was a comparatively short length of line seriously damaged. At the points where the line crossed gulleys which could not be filled with rock for any reason, the slope was held with cedar cribs. Not one of these cribs was seriously affected by the flood, the only damage done being to empty two or three of the pockets by washing out of the crevices the loose material below the foundation. In replacing the lost work, cribs were used entirely.

Nothing of special interest has happened on the line since that time. A very heavy snowstorm in November, 1892, drove all the men out of the upper division of the line. This snow finally got away so that work could be resumed during the last week of June of the present year. In the meantime work in the canyon was completed and the track laid up to the snow. The line of retreating snow has been followed since March, from the canyon up, and track is now (Aug. 25, 1893) up to Monte Cristo.

There are views of great scenic beauty all along the line, the most striking thing being the nearness of the walls of the canyon. The gorge is narrow and the tourist can, as it were, touch as well as view. There are walls and slopes of mountains all alonge above the canyon; sometimes near, sometimes off a mile or so, nearly all wooded to the summit. On the upper part of the line, however, the peaks are so high, so steep and craggy that timber disappears in many places. Not even the snow can lie here, but comes coursing down in slides. The only animate thing that can stay there is the mountain goat. At Monte Cristo on the left comes Glacier Creek, on the right "76" Creek, both fed from the same glacier, high on the mountain slopes.

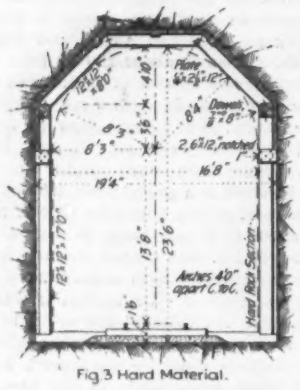


Fig. 3 Hard Material.

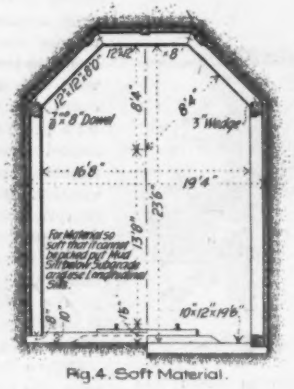


Fig. 4. Soft Material.

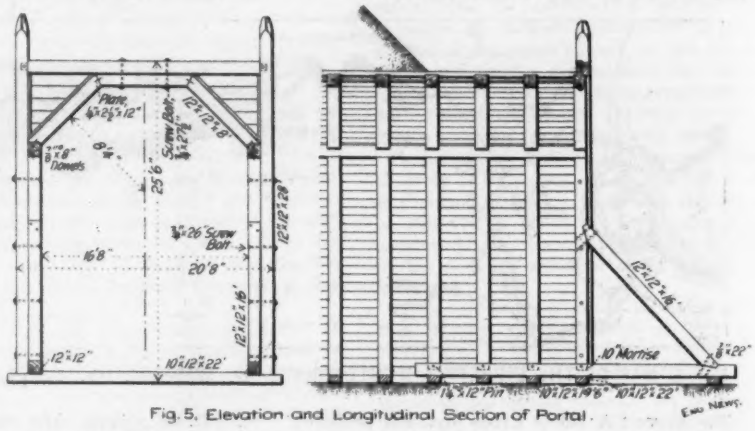


Fig. 5. Elevation and Longitudinal Section of Portal.

FIGS. 3, 4 AND 5. DETAILS OF TIMBER LINING FOR TUNNELS 1 TO 6, INCLUSIVE.

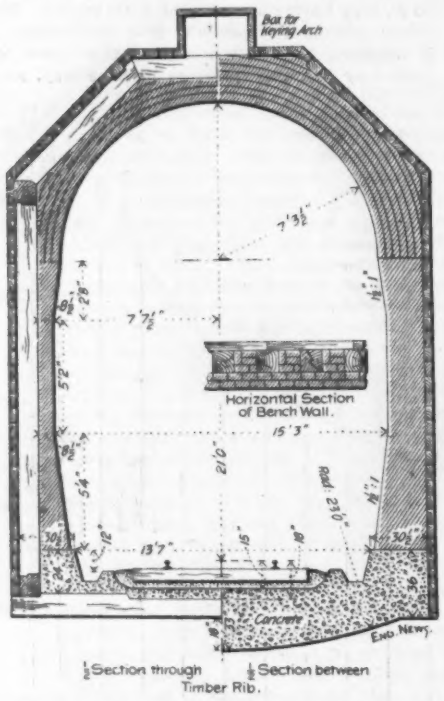


Fig. 7. Masonry Section Adopted for Tunnel 7.

A SAND SUCTION DREDGE OF 4,000 TONS PER HOUR CAPACITY.

A suction sand dredge with a capacity of 4,000 tons per hour has been built by the Naval Construction & Armaments Co., of Barrow-in-Furness, England, for work on the Mersey bar, near Liverpool. This is claimed to be the largest dredge in existence. The sand pumping machinery consists of two centrifugal pumps with 36-in. suction and delivery pipes. These pumps are on each side of a well and draw from a T-head at the top of the suction pipe, and around this head as a trunnion the tube can be raised or lowered to suit the depth of the water and a ball-and-socket joint gives a certain amount of lateral motion. The suction nozzle is turned over at the bottom with its aperture almost at right angles to the axis of the tube.

The hull of the dredge is 320 ft. long by 46 ft. 10 ins. wide with a depth of 20 ft. 6 ins., and the loaded draft is 16 ft. 4 ins. She has twin screw engines and a speed of 10 knots loaded. The sand is pumped into hoppers and on a recent trial on the Mersey these hoppers were filled at the rate of 100 tons per minute. The designing engineer was Mr. A. Blechynden, Chief Engineer of the company referred to.

SANITARY ANALYSES OF DEEP ARTESIAN WATERS.

It is generally held that water from deep artesian wells must, from the nature of its source, be free from organic matter and, therefore, eminently fitted for domestic use, unless too highly impregnated with mineral matter. In a paper read before the American Water-Works Association at its recent Milwaukee meeting, Prof. Erastus G. Smith, of Beloit, Wis., read a paper on "Artesian Wells as a Source of Water Supply." Some of the points made in the paper were mentioned in our report of the convention (Eng. News, Sept. 14). An abstract of a portion of the paper relating to the significance of sanitary analyses of deep well waters is given below:

The analyses of water from deep artesian wells which I have made or collected almost without exception show either an absence of organic matter or else an astonishing amount of one determination, as for example, free ammonia. It is significant that while the free ammonia is so high, nitrogen in other forms, as albuminoid ammonia, nitrites and nitrates, is wanting. The following 10 analyses, made at the Beloit laboratory, illustrate this point:

(Grains per U. S. Gallon.)

Well at:	Depth ft.	Total solids.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrogen as Nitrites.	Nitrogen as Nitrates.
Whitewater, Wis.	315	.16.7	0.15	0.01	0.00	0.00
Massillon, O.	203	.15.4	0.45	0.01	0.00	0.00
Chicago, Ill.	400	.13.6	0.26	0.07	0.00	0.00
Van Wert, O.	53	.93.5	0.52	0.03	0.00	0.00
Van Wert, O.	98	.93.9	0.59	0.02	0.00	0.00
La Grange, Ill.	2,100	.31.6	0 40	0.05	0.00	0.00
Peru, Ill.	1,300	.49.5	1 08	0.05	0.00	0.00
Hillsboro, Ill.	400	.59 1	1.20	0.01	0.00	0.00
Harvey, Ill.	1,300	.88	0 90	0 00	0.00	0.00
Davenport, Ill.	1,067	.73.2	0.90	0.01	0.00	0.00

The presence of any such amount of free ammonia in surface water would cause the water to be viewed with grave suspicion, if not positively condemned, and an application of surface water standards to the artesian well waters also leads to their condemnation. It is to be specially noted, however, that we have the nitrogen aggregated into the one form of ammonia and not distributed through the four forms usually met with; and I think it becomes remarkable and attracts attention, because thus aggregated into the single form and not distributed through the four forms. A simple calculation of the nitrogen changed into and distributed through these usual forms would show it to fall well within our accepted standards for maximum impurity of waters.

The fact of so much ammonia so often found in these deep waters, its significance and cause were to me for a long time a source of perplexity and anxiety on being required to pass a correct opinion on their sanitary nature. The samples had been very carefully collected in my own glass-stoppered bottles, thoroughly cleaned before leaving the laboratory and protected from intruding ammonia on return. Duplicate well-checking analyses from different bottles proved that the amount of ammonia truly represented the ammonia normally present in the water.

A chance visit to one of the wells revealed the presence, in traces, of sulphuretted hydrogen, and suggested a reasonable explanation of the difficulty. Personal inspection of seven of the wells in the above table expressly to determine this point, and correspondence regarding all others containing high ammonia coming under my observation, have shown the presence of this sulphuretted hydrogen in the waters. Thus the extraordinary ammonia can be explained on the basis that the sulphuretted hydrogen has exerted its well known reducing action, either reducing the higher oxidized compounds of nitrogen back to ammonia or preventing entirely their formation. This explanation seems to me perfectly satisfactory and reasonable and to meet the case. It may be that other agencies, as the iron oxide dissolved in these waters, also lend their assistance to the final result, but probably the sulphuretted hydrogen is the principal one at work.

On this basis of explanation it is fair to question whether any amount of ammonia up to 1 + per million at least has any significance for these deep wells. Our ordinary standards of maximum impurity (e. g., 0.08 free ammonia per million) utterly fail when applied to any such data as are cited above. The above explanation has satisfactorily met all cases coming thus far under my observation, and it will be a matter of great interest to see whether it may coincide with the experience of others and may sufficiently meet future inquiries and developments.

Regarding the gases present in these deep artesian wells, I would note the carbonic acid gas almost always present in the free state and by virtue of which the carbonate of lime and magnesia are held in solution. Oxygen, according to the eminent analyst, Dr. Brown, of Boston, is always absent in these deep wells. Sulphuretted hydrogen is very often present. It is, however, very elusive and disappears rapidly and wholly on relief of the waters from pressure and on aeration.

FOUNDATIONS FOR THE MAIN POWER STATION BROADWAY CABLE RY.

The main power station of the Broadway cable railway in New York city, presents an interesting peculiarity in the design of its foundations. As the land on which the building stands is very costly, it was desirable to utilize the upper stories for renting for stores and offices, and it became a serious problem whether this could be done on account of the vibration of the large engines for driving the cables, which were to be placed in the basement, since if the vibrations were to be communicated to the superstructure the offices would hardly be rentable. It was evident that such communication would take place if the foundations of the engines had any connection with those of the building, consequently a hint was borrowed from the construction of astronomical observatories, and independent foundations were designed for the machinery and building. This arrangement is shown in the accompanying illustrations. In our issue of Aug. 22, 1891, we published details of the cable conduits and roadbed.

The building is nine stories high above the street and fronts 125 ft. on Broadway and 200 ft. on Houston St. The power machinery is placed in the basement and below this at a depth of 42 ft. below the street level is a sub-basement. The architects were McKim, Mead & White, of New York city.

Briefly stated, the walls of the building rest on a layer of concrete forming the sub-basement floor, a part plan of which is shown in Fig. 1, as is clearly shown in the section, Fig. 2. These walls are of brick and at a height of 25 ft. they inclose a series of 29 Phoenix columns resting on a steel I-beam grillage, as shown in Fig. 3. To support the interior walls of the building there are 45 Phoenix columns 38 ft. 2 ins. high, including base, located as shown by the dotted circles in Fig. 1. These interior columns rest upon steel I-beam grillages inclosed within steel cylinders 6 ft. high, with diameters varying from 4 to 12 ft. The cylinders are sunk below the sub-basement floor and for about 3 ft. of their height are filled with concrete which furnishes the immediate support of the grillages. Enlarged details of the foundation for one of these columns are shown in Fig. 4. Between the cylinders is a bed of concrete 2½ ft. thick which forms the sub-basement floor.

The foundations for the machinery consist of brick piers resting on the concrete of the sub-basement floor. The location of the footing courses of these piers is shown in Fig. 1, and a general plan of the piers and walls, showing the manner in which the portions of the walls overlying the column foundations are carried across them by I-beams, is shown in Fig. 5. It will be seen that the machinery is quite independent of the deeper foundation of the columns, from which the vibration has to be eliminated.

Since the foundations of the building were considerably below the ground water level, the chief difficulty encountered in the work was from this source. The method adopted was to lower the level of the water by sinking tube wells and pumping. Two rows of 2-in. tube wells comprising in all 30 wells were sunk about 10 ft. or 12 ft. below the sub-basement floor, or from 5 ft. to 6 ft. below the lowest foundations. The two rows were 6 ft. apart and the wells in each row 12 ft. apart. These wells were sunk at one side of the lot, as it was intended at first to sink another series on the other side, but as the work progressed this was found unnecessary. The water was taken out by a couple of Smith & Vaile pumps.

The work, as described, was carried out according to the plans of Mr. Geo. W. McNulty, M. Am. Soc. C. E., Chief Engineer, Broadway & Seventh Ave. Cable R. R. Mr. H. W. Brinckerhoff, M. Am. Soc. C. E., was Assistant Engineer, and we are indebted to this gentleman for the matter from which our illustrations have been prepared.

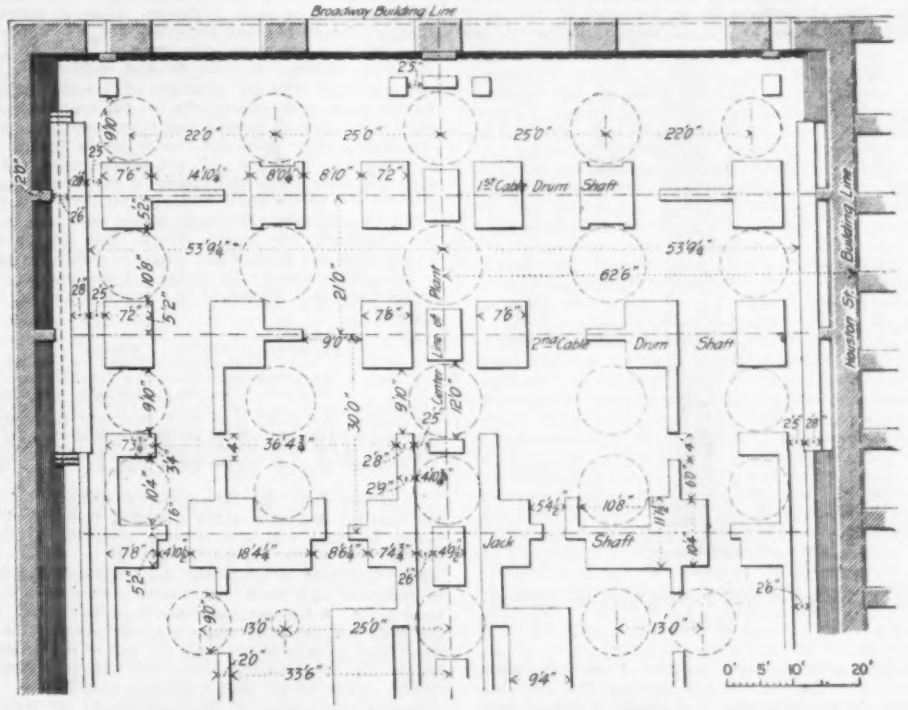


FIG. 1. PLAN OF SUB BASEMENT FLOOR OF HOUSTON ST. POWER STATION BROADWAY CABLE RAILWAY, SHOWING FOOTING COURSES OF PIERS AND LOCATION OF CYLINDERS.

MICROSTRUCTURE OF STEEL.*

Crystallization of Steel.—The following propositions and corollaries are intended to present, as concisely as possible, some of the evidences gathered while studying the microstructure of steel.

Proposition I.—A slow and undisturbed cooling from a temperature x or higher produces crystallization.

Proposition II.—Undisturbed cooling from an initial temperature lower than x is not accompanied by crystallization. In a piece of rail steel forged from a white heat until it had fallen to dull red, the structure is almost amorphous; practically no crystallization has taken place during the subsequent cooling. Corollary.—Pieces of steel finished at a temperature lower than x do not take a crystalline structure.

Proposition III.—The temperature x varies with the chemical composition of the steel. Each impurity (at least, carbon and phosphorus) lowers x, although in widely different degree. Photomicrographs of the structure of two pieces of steel similarly treated and varying in composition only by their percentages of phosphorus, which are respectively 0.145 and 0.063%, show that the high phosphorus and high carbon steels have respectively a much larger grain than the low phosphorus and low carbon. The crystallization of the former has kept on (the grain has continued to increase) long after it had ceased in the latter. Corollary I.—Carbon and phosphorus and probably all impurities, at least when present up to a certain amount, increase the size of the grain. Carbon, by increasing the amount of carbide of iron (which is the hard constituent of steel) confers hardness and strength on the metal; by increasing the size of the grain it causes decrease of ductility and eventually brittleness. This, of course, can be diminished to a great extent by proper heat treatment. Corollary II.—The purer the steel, the higher the finishing temperature can be without causing coarse crystallization.

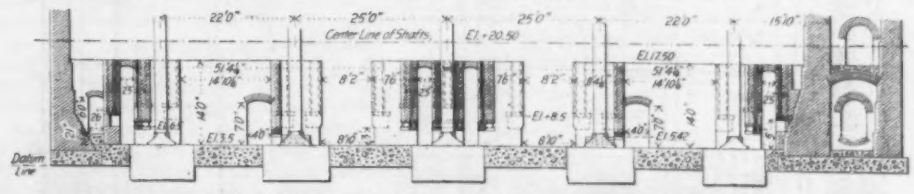


FIG. 2. SECTION THROUGH MACHINERY FOUNDATIONS SHOWING PIER WALLS.

Properly conducted experiments might teach us what this temperature x is for various chemical compositions; and the knowledge would be extremely valuable. It would tell us at what temperature a steel of a given chemical composition should be finished, in order to avoid an objectionable crystalline structure. Although this is certainly a complex problem, it is not, we believe, an insoluble one. In the latter part of this paper we have outlined a method of working which, so far as it has been tested, has given gratifying results, and which may furnish the means of getting the desired information.

Proposition IV.—The higher the initial temperature from which the steel is allowed to cool undisturbed, the larger the grain for a given composition.

Proposition V.—The slower the cooling the larger the grain for a given composition. Corollary (to Propositions IV. and V.).—Finished pieces of steel will have a coarser grain in those places which have been finished hottest, and where subsequent cooling has been more gradual.

Proposition VI.—The size of the grain is independent of the amount of work the metal has received.

If two test ingots taken from the same heat, one, say, 4 ins. and the other 2 ins., square, are forged down to, say, 1 in. square, the bar reduced from the larger ingot will show the smaller grain. At first it might be inferred that the smaller grain is due, partly, at least, to the greater amount of work received by the larger ingot, but we believe it is caused only by the lower temperature at which that bar was necessarily finished; for, instead of being left to cool slowly after forging, from their respective temperatures, both bars are similarly heated, say, to a bright red, and then slowly cooled, they will take the same structure. This, at all events, is an argument in favor of the non-ex-

*Abstract of a paper by Albert Sauveur, South Chicago, Ill., read before the American Institute of Mining Engineers at the Chicago meeting, being part of the International Engineering Congress, August, 1893.

istence of a "special effect of work." Work as such seems to have no effect on the grain of the steel; and it is hard to understand how a treatment which does not alter the structure of a metal can influence its physical properties.

Microstructure of Steel Rails.—A polished and etched section of a steel rail when examined under the microscope does not by any means reveal in all its parts the same structure. This heterogeneousness of structure is due to the different temperatures at which the various parts of the rail leave the finishing rolls, and to the unequal rate of their subsequent cooling. The proportions formulated in the first part of this paper should enable us to foretell such variations in the

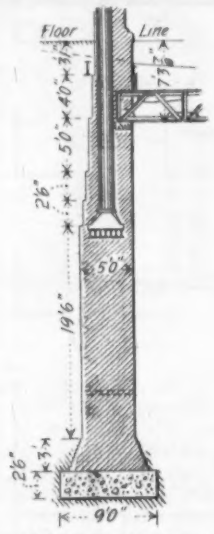


Fig. 3. Section of Wall Showing Location of Phœnix Column.

structure of a rail. The outside of the rail leaving the rolls coldest and cooling quickest will offer less chance for crystallization, and should, therefore, show a smaller grain than the inside, which, being the hottest and cooling down more slowly, will favor the crystallization of the metal, the size of the crystals or grains reaching its maximum in the center of the head. It might also be inferred that the smallest grain will be found at the extremities of the flange, since this is always the coldest finished region. Proceeding from the outside to the inside we shall find the tendency toward coarse crystallization gradually increasing.

The same propositions tell us, moreover, that for a given chemical composition, the higher the finishing temperature of the rail and the slower the cooling, the more pronounced will be the crystallization. It follows also that the heavier the rail the more crystalline will be its structure, for it will generally be finished hotter than a lighter one. It is a necessary consequence of such variations of structure that the physical properties of the different parts of the rails should vary accordingly. As might be expected, the crystalline structure of the center of the head will show less power of elongation and of reduction of area than the closer structure of the side of the head, and especially of the extremities of the flange. Test bars were cut from three different locations and submitted to tensile strain. The results agreed remarkably well with the microscopical evidences. Thus it appears that, so far as physical properties are concerned, a steel rail is a somewhat heterogeneous body. This is the more apparent in rails finished unduly hot. In colder finished rails the difference of structure of the various parts (and consequently the difference in their physical properties) is much less pronounced. The accompanying table gives the results of the testing of bars cut from both hot and cold finished rails, rolled from the same heat. The figures of the first column give the size of the grain, in square millimeters, magnified 100 diameters. We shall explain later how they were obtained. The figures of this table agree very closely with our propositions that the colder the rail is finished the smaller its grain, and the smaller the grains the higher its power of elongation and of reduction.

	Size of grain in sq. mm. magnified 100 diam.		Tensile strength. Lbs. per sq. in.		Elongation. Per cent. of length.		Reduction. Per cent.	
Test bars, cut from:	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.	Hot.	Cold.
C't'r of head	118	85	99 900	100,970	15	20⅛	20	23
Side of head	112	75	100,000	103,900	19	20	22	32½
E'd of flange	62	35	102,900	105,60	22½	21	35	39

It follows from the heterogeneous structure of a rail that the deflection which a bending test will give before breaking will greatly vary according to the region from which the test is cut. It is, therefore, highly important in comparing the toughness of rails by means of such tests to cut them always from the same parts. A bending test taken from the center of the head will generally make a poorer showing than those from the side of the head, the web or the flange; but it will more readily reveal the hurtful crystallization caused by too high a finishing temperature.

Another consequence of this variation in the structure is that when rails are in use, some portions, more yielding, will not bear their fair share of the stress, but will throw it partly upon the other more resisting portions, thus reducing the power of endurance of the rail as a whole. It seems, then, that the ideal rail should have as homogeneous a structure and as small a grain as possible. Theoretically, we should get nearer to this result by finishing cold (not so cold, however, as to produce the brittleness due to cold rolling) and cooling quickly; or by reheating the rail to a temperature from which on subsequent cooling the metal does not crystallize.

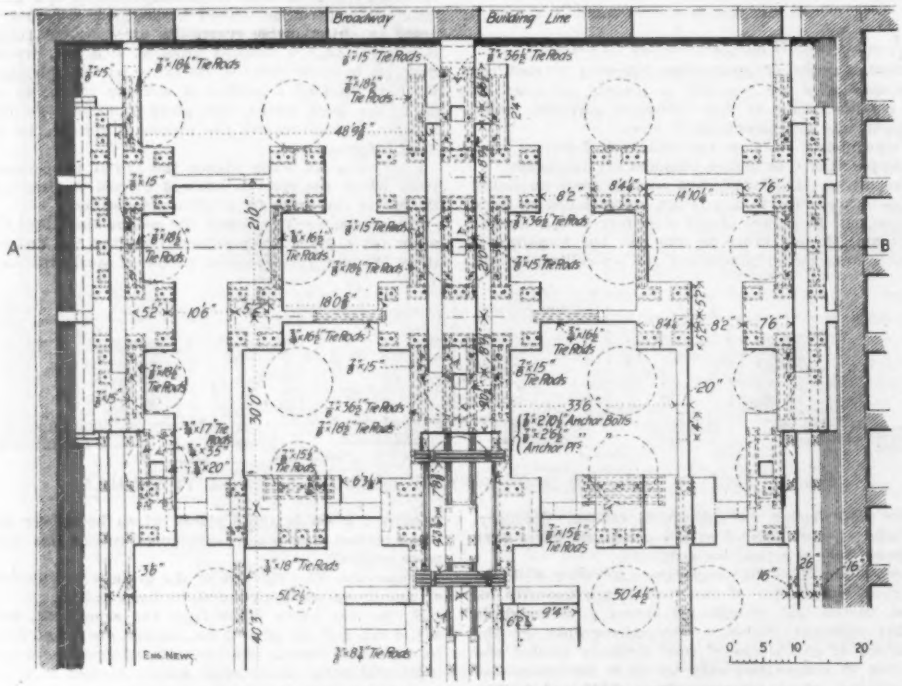
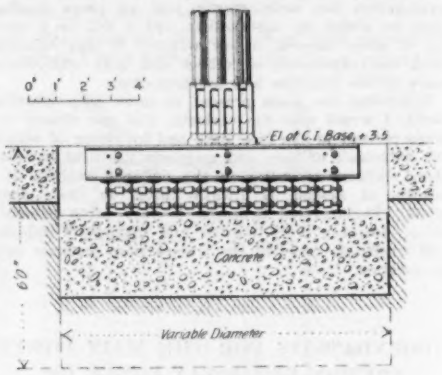


FIG. 5. PLANS OF PIERS AND WALLS FOR MACHINERY FOUNDATIONS.

III. Some Experiments on the Relation between the Physical Properties of Steel and Its Microstructure.—When a piece of steel has failed to meet expectation, whether under preliminary test or in actual use, we generally turn to chemical analysis for an explanation of the failure. The investigations may occasionally include the cutting and testing of some test bars



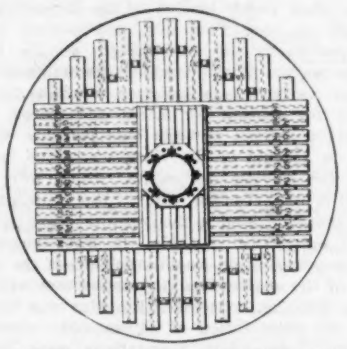


Fig. 4. Details of Foundation for Interior Columns.

and the etching of a section of the deficient piece, but it rarely amounts to more, at least as far as rails are concerned. Seldom, if ever, do we stop to inquire whether the heat treatment may not have been defective. But this is not a factor that should be disregarded in view of its all-important effect on the structure and consequently on the properties of the metal. No doubt our neglect of it is chiefly due to the lack of means at our disposal for ascertaining with sufficient accuracy what the past heat treatment of a finished piece has been. Yet heat treatment leaves its unmistakable impress on the structure of the metal. Jointly with the chemical composition it regulates the grain. If we could find to what extent each of these two variables contributes to the formation of the grain, then the final result being known and one of the factors (the composition), the other could easily be inferred. It is here that the microscope seems destined to become an extremely important instrument for the steel manufacturer, since it furnishes us the means of estimating the final result, the size of the grain. In other words, from the size of the grain of the steel under consideration and its chemical composition, we could infer what its heat treatment has been, and this would indeed be a very valuable piece of information and might explain many failures which chemical analysis had left unaccounted for.

In the following pages we use the names given by H. M. Howe to the different constituents of steel described by Dr. Sorby. It will, perhaps, be well to briefly recall their meaning. As far as the microscope has been able to ascertain, all steels not quenched seem to be made up of three constituents, namely, ferrite, cementite and pearlyte. Ferrite is iron free from carbon. Cementite is iron with cement carbon, probably a carbide answering to the formula Fe_3C; it is the hard constituent of steel. Pearlyte, when examined under high power (at least 300 diameters), shows itself to be a mixture made up of very thin plates alternately of ferrite and cementite in the proportion of two-thirds ferrite to one-third cementite. It has a pearly appearance, whence its name. It seems as if during slow cooling the ferrite and cementite combine as far as possible, leaving an excess of ferrite or of cementite, as the case may be.

We have seen that all steels crystallize when allowed to cool undisturbed from a sufficiently high temperature. This crystalline structure is composed, roughly speaking, of grains of pearlyte surrounded either by ferrite (in the case of soft steel or steel of medium hardness) or by cementite (in the case of harder steel). A section cut at any angle through the metal will exhibit what we may call a network structure, the pearlyte forming the meshes, the ferrite or cementite the network itself.

In the case of very soft steel the grain is very small

and the proportion of ferrite is considerable, but we may still compare the structure of a section cut through such a steel to a network with small meshes and an exaggerated net.

Now the physical properties of a sound piece of steel depend: 1, On the proportion of pearlyte and ferrite, or pearlyte and cementite, present in the metal (and this is governed solely by the percentage of carbon); and, 2, On the size of the grain, which, in turn, is a result of the chemical composition and heat treatment.

In the following experiments we have endeavored to ascertain the relation between the size of the grain and the properties of the metal. We started with the intention of considering only these two variables, namely, size of grain and physical properties, hoping to be able, by the plotting of a sufficient number of cases to get some curve from which we could foretell with fair accuracy the properties of a steel, the size of the grain of which was known. We soon found, however, that it was necessary to take into consideration a third variable, namely, the percentage of carbon, on which depends the relative amounts of pearlyte and ferrite (or cementite) present. This will be easily understood, for, although two steels may have the same grain if they contain respectively, say, 10 and 50% of ferrite, their proportions must be very different. The grains of the former will be farther apart, the interspace being filled with soft ferrite, while only a narrow net of ferrite will separate the grains of the latter.

Consequently, a constant relation between the size of the grain and the quality of the metal can exist only, if at all, among steels with the same, or nearly the same, carbon content. Hence the necessity to classify our results into groups corresponding to each percentage of carbon, or at least to each variation of 0.05 or 0.10 in that percentage. For instance, all the rail steels containing from 0.30 to 0.40% carbon will form one group, while the soft steels, with from 0.10 to 0.15% carbon will form another.

But, before going any farther, it will be well briefly to describe here our method of proceeding to ascertain the size of the grains. Our outfit for that purpose consists of a microscope and its accessories, a camera lucida (Abbe's improved design), and a planimeter. The sample whose grain it is proposed to measure is carefully polished and etched in the usual way. The microscope is kept in a vertical position. In the middle of our table, by the side of the microscope, is a round board, carrying a sheet of white paper and the planimeter, and capable of being raised or lowered at will by means of a screw motion. We are thus enabled to keep a constant distance between the eyepiece and the paper, securing for specimens of different thicknesses a uniform enlargement. The specimen and paper being properly illuminated, it will be found comparatively easy, after a little practice, to follow accurately the outline of any grain with the steel point of the planimeter, thus ascertaining its area. Or, if found more convenient, the outline of the grain may be first traced with a pencil on a sheet of paper, and the area afterwards measured with the planimeter.

In many cases the lines of demarcation of some grains appear, in certain places, very faint, or their course doubtful; but we can generally complete them with the pencil, without introducing much error in the figuring of the size of the average grain. What we call here grains are, of course, the meshes of our network. These are the sections through the grains of the steel; and for the sake of comparison, the average area of such sections is just as good as the average surface or the average volume of the grain itself. Such enlargement is used as is found desirable to enlarge the grains to a convenient size. Of course, in dealing with small grains, such as those of very soft steel, or of harder steel finished very cold, a much higher magnifying power is needed. In some instances as high a power as the one furnished by a one-twelfth in. objective will be found necessary to enlarge the grains sufficiently. In plotting our results we have reduced all our areas to a uniform enlargement of 100 diameters.

With steel of average hardness, the amount of ferrite is very small; the grains are in close contact, and the work of measuring can generally be much shortened by neglecting altogether the area occupied by the network itself. All that is necessary then is merely to follow with the planimeter the outline of the space including all the full grains visible in the field of the microscope, to count them out and to figure the average area.

In dealing with soft steel, this method is no longer possible. It is then necessary to measure individually a sufficient number of grains.

Most of our test-bars were cut ¾ in. square and 20 ins. long. A thin section was cut at one end of each test, polished, etched and its grain measured. The tests were then subjected to tensile strains and the maximum load in pounds per sq. in. and the elongation and reduction per cent. were recorded. At this early stage of our experiments, we can only publish the results we have obtained for rail steel. In the plotted diagram the lines of reduction and elongation follow remarkably well the changes in the size of the grain; both falling rapidly as the grain increases, and the reduction diminishing more rapidly than the elongation. The size of grain does not by any means so much affect the tensile strength. The fall of that line is very gentle. The grain increasing from 35 to 221 sq. mm., i. e., six-fold, the corresponding decrease of tensile strength is only about 10,000 lbs.

Will the tensile strength curve continue to fall with further increase of the grain? If we consider the only two cases plotted and corresponding to a grain of 338 and 376 sq. mm. respectively, we notice a decided increase of tensile strength; but of course many more steels with such grains will have to be tested before we can venture to show any conclusion.

These results show that there is a constant relation between the size of the grains and the properties of the metal, and what that relation is. They constitute, however, only the first step toward a very extensive series of experiments necessary to accomplish our purpose. We must next endeavor to determine the extent to which the grain is affected by different finishing temperatures and by each unit of the various impurities, carbon, silicon, sulphur, manganese and phosphorus.

If the plotting of a sufficient number of cases should reveal a constant relation between these variables and the size of the grain, it will be seen at a glance what extremely useful results would follow. We should be enabled to detect improper heat-treatment. Tables could be constructed from our curves, which would give the size of the grain corresponding to a given chemical composition and a given heat treatment, and consequently the physical properties of a steel produced under these conditions.

Such tables would help us to solve the two very important questions: What heat-treatment will best suit a given chemical composition, so as to get a certain desirable structure? and what chemical composition will best suit a certain heat-treatment, desirable for mechanical reasons, economy, etc., so as to get the desired structure?

Already in the present state of our knowledge, we get much useful information from microscopic examination of the steel, especially when it includes the measurement of the grain.

Such a method throws much light on the way a certain steel is affected by a certain heat-treatment. It shows, within limits, what maximum finishing-temperature a steel of a given composition will stand, without assuming an objectionable crystalline structure. But, above all, it tells us a great deal about the past heat-treatment of the metal. If the piece of steel under examination shows a size of grain which is not justified by its chemical composition, it is safe to infer that the heat treatment has been defective; the metal was allowed to cool undisturbed from too high a temperature, thus inducing coarse crystallization.

I here desire to express my thanks to Mr. W. C. Post, of the Illinois Steel Co. for his conscientious assistance and his careful preparation of the specimens.

PERSONALS.

Mr. G. H. Nickerson has been appointed Assistant City Engineer of Salt Lake City, Utah.

Mr. S. W. McConnell, of the engineer staff of the Pittsburg, Fort Wayne & Chicago Ry., has resigned to accept the position of Superintendent of the Newport Iron Ore & Copper Co., of Ironwood, Mich.

Mr. Jas. D. Mason, Engineer of the Department of Transportation Exhibits at the World's Fair, will engage in general civil engineering practice, and has opened an office at 637 Rialto Building, Chicago.

Mr. H. L. Flanders, formerly Superintendent of the Central division of the Missouri Pacific Ry., has been appointed Superintendent of a division on the Mexican Central Ry., with headquarters at the City of Mexico.

Mr. Thomas Hawksley, F. R. S., Past President of the Institution of Civil Engineers and one of the best known engineers in the world, died on Sept. 24, aged 84. Mr. Hawksley was made a Member of the Institution on April 7, 1840.

Mr. Lewis K. Davis, M. Am. Soc. M. E., M. Am. Inst. M. E., and until recently Manager Engineering Department of the National Lead Co., of New York city, has resigned and opened an office as a consulting and constructing engineer at Room 200, 1 Broadway, New York. His specialty will be the designing and construction of power plants for electric railways, water-works, coal and ore docks and heavy machinery in general, along which lines he has had considerable experience.

NEW PUBLICATIONS.

OCTOBER MAGAZINES.—"Harper's" has a masterly paper by Carl Schurz, discussing what should be the future policy of the United States with regard to annexation of further territory. He argues that no territory should be acquired whose inhabitants are not fitted for self-government, so that they can be admitted to equal privileges with our own people in the conduct of the general government. "Scribner's" has an excellent description of the mounted police of the Canadian Northwest, with illustrations by Frederic Remington. In the "Nineteenth Century" is a view of "American Life through English Spectacles," which will interest Americans, doubtless, even more than the Englishmen for whom it was written. In the "Popular Science Monthly" we find papers on the electrical exhibits at the Fair, and the exhibits of household arts there. A brief paper on Werner Siemens is accompanied by a finely engraved portrait of that distinguished scientist and engineer.

In "The Century" Wm. Fortune writes on "Street Paving in America." It is written, of course, for the popular reader; but at least one fact in it will, we believe, be new to many engineers. It is common to see any kind of granite or trap block pavement referred to as a "Belgian block pavement." This usage is incorrect. The Belgian block pavement is, or was (for not much of it is now in use), a pavement composed of stone blocks of approximately cubical form, so that the wearing surface of the block is about square. As this was the distinguishing feature of the Belgian block it is a mistake to apply the name to the rectangular blocks used in modern stone block paving. The author's comments on brick pavements deserve especial praise; but he does not do justice to macadam and telford paving when he says "they are better suited to driveways and country roads than to inhabited streets, because they are almost constantly other dusty or muddy, owing to the detritus of their surfaces." For suburban streets, where small cost is an essential, no pavement can compare with broken stone, and on such well made and well kept streets as the boulevards of Chicago, for example, we question if any more costly pavement could give, on the whole, as satisfactory results. Another paper in this magazine which deserves mention here is a description of the Pratt Institute, Brooklyn's famous school, where art, science, business and other things too numerous to mention are taught, and where manual training has been carried to a high degree of perfection. Mrs. Schuyler Van Rensselaer contributes a sketch of Frederick Law Olmsted, the landscape architect.

In the "North American Review" Admiral Colomb, of the British Navy, discusses "The Battleship of the Future," without, however, coming to any very clear conclusion as to what the battle ship of the future will be. He wholly omits to mention the influence which the perfection of the submarine torpedo boat is destined to have on the battle ship of the future, probably for the reason that the rapid progress of submarine navigation is destined very soon to make the building and operation of battle ships of any sort the veriest folly. Imagine the feelings of the commander of a three-million dollar iron-clad who sees a diminutive vessel rise out of the water a few yards away and is informed by the officer of the craft that he can have the alternative of immediate surrender or having his vessel blown up by the torpedo which has already been attached to its bottom. It is fortunate for the United States that its expenditures on its new navy have not reached the extravagant proportions which many of its overpatriotic citizens have urged. Three members of the Ways and Means Committee discuss "Coming Tariff Legislation." Those who speak for the Democratic side deny any intention to injure manufacturing interests, and say that they are working for free raw material, low duties on necessities and high rates on luxuries. "The Review of Reviews" has a paper by Wm. E. Smythe, editor of the "Irrigation Age," entitled "The Irrigation Idea and Its Coming Congress." According to this paper the legal and financial questions connected with irrigation will be the ones to which the convention will devote most of its time; and it is these chiefly which are considered in the paper.

TRADE PUBLICATIONS.

STEAM BOILERS. E. Hodge & Co., East Boston, Mass. John E. Lynch, Proprietor. Pamph., 8vo, pp. 45, 19 illustrations.

The works whose products are catalogued in this pamphlet, was established in 1864. We notice the statement that wrought iron is now only used for boiler shells and heads when it is specially ordered by the customer. The specifications used require the plate to be of open-hearth steel with a tensile strength between 55,000 and 60,000 lbs. per sq. in., and an elongation of not less than 25% or more than 30% in 8 ins. Fixing a maximum limit for elongation is a new idea to us. Calking is done with a round nosed pneumatic tool. For pressures above 100 lbs per sq. in. a triple-riveted butt joint with both inside and outside cover plates is used. A feature especially commendable is the non-use of the steam dome unless it is ordered by the purchaser. Boilers of the locomotive type are still built with crown bars, in accordance with New England railway practice. Besides boiler work the firm has built a number of stand-pipes for water-works service.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF PHILADELPHIA.—During the stay of the French engineers in Philadelphia they were entertained by a committee of this society consisting of Messrs. John C. Trautwine, Jr., Henry V. Loss and E. K. Landis. The visitors were met at Broad St. station on their arrival, and after examining that structure under the guidance of Chief Engineer Wm. H. Brown they were escorted across the street to the City Hall, where they were introduced to Mayor Stuart by Mr. John Birkinbine, President of the Club. After inspecting the City Hall, the Reading Terminal station and Independence Hall, the visitors were escorted to their hotel. In the evening an informal reception was held at the club house. The two following days were spent in visits to the Cramp' shipyard, the harber improvements and various public works and manufactories of the city.

MONTANA SOCIETY OF CIVIL ENGINEERS.—At the last regular meeting of the society Mr. E. H. Beckler, late Chief Engineer of the Pacific extens'on of the Great Northern Ry., was unanimously elected an honorary member of the society. Mr. Beckler is the first member of this society elected to honorary membership, and in conferring this honor the Montana Society did so in recognition of Mr. Beckler's high attainments as engineer, and especially in view of the high professional ability he displayed in the location and construction of the Pacific extension of the Great Northern Ry., of which he was the Chief Engineer.

In the accomplishment of this great work he secured a route through the main range of the Rocky Mountains with lower gradients than any other transcontinental line, the maximum gradient east of the summit being but 1%, and west of the summit 1.8%. The crossing of the Cascade Mountains is made with a maximum grade of 2.2%, and on a route so direct that the distance from Spokane, Wash., to Puget Sound is shortened 94 miles over any other route. The location for most of the distance was through an unexplored and mountainous country, and the work of construction under Mr. Beckler's direction was pushed in a manner heretofore unequaled in railway building and tracklaying. The entire distance of 818 miles was completed in a little over two years from the time construction work was inaugurated.

G. O. Foss, Secretary.

CENTRAL RAILWAY CLUB.—At the meeting on Sept. 27 the subjects discussed were "Lubrication of Cars" and "Inspection of Locomotive Boilers." On the first subject a report was presented by Mr. E. D. Bronner of the Michigan Central. He said that more oil was wasted on the roadbed than was actually used for car lubrication. Too much oil is put into boxes, and when this is not done the packing carries up the oil and it works out at the back of the box. A good dust guard will prevent this to a certain extent, but all dust guards need to be closely watched to keep them in good condition.

Particular attention should be paid to see that trucks do not leave the repair shop with bearings out of square. Bearings should be of solid brass or bronze bored to size, with a thin lining of soft metal, and should be lubricated before being put in place. One great cause of hot boxes in early winter or in late spring is the use of lubricating oils which are not of the proper cold test. Mr. Waitt said that axles made of scrap iron had proved especially prone to heat. He had not found a hot box, however, where the M. C. B. 4½ × 8 in. journal was used. Mr. Bronner said that on the Michigan Central oil costs 6 cts. per 1,000 miles on freight cars, and 26 cts. on passenger cars.

On the second subject Mr. Geo. W. West advocated a general inspection of every boiler once a year by removing the flues and putting a man inside. The usual discussion ensued as to the best method of inspecting stay bolts, winding up as usual with the conclusion that the hollow or drilled bolt, which would give warning at once in case of breakage and would do away with most of the need of inspection, was the best safeguard.

At the next meeting Messrs. J. A.Chubb, Jas. Macbeth and Robert Gunn will report on Air Brake Inspection and Maintenance. Messrs. W. Lavery, P. E. Garreson and John Mackenzie will report on "Heating of Driving Boxes and Eccentrics."

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The program of entertainment tendered by this society to the party of French engineers now visiting this country, during their stay in Pittsburg, rivals in completeness the excursions enjoyed by the visiting English and German metallurgists during their stay at Pittsburg three years ago. The first excursion was on Friday, Sept. 22, when the party, accompanied by the members of the local committee, was taken by train over the Panhandle lines to the Jumbo mine of the Pittsburg Consolidated Coal Co., where the operation of compressed air coal mining machinery was witnessed. Well No. 15 of the Forest Oil Co., in the McDonald oil and gas field, was the next stop, and the well was "torpedoed" for the visitor's entertainment. The usual novel sights in connection with the natural gas production were also shown the visitors. The Gregg station pumping plant on the W. L. Mellon pipe line was the next halting point. Oil from the West Virginia fields is pumped through a 5-in. line of pipe, and goes with the local production to the seaboard. There are five pumping stations in a length of 290 miles. The pressures on the line reach 1,000 lbs. per sq. in. The line attains an altitude of 2,750 ft. above sea level, and 2,550,000 barrels of oil pass through it annually. After a luncheon on the train the afternoon was spent in visiting the smelting works of the Pennsylvania Lead Co., and the works of the Westinghouse Electric Company.

Saturday was devoted to a river excursion on the steamer "Mason." The forenoon was spent in the journey to the Homestead Steel Works and an examination of the great plant at that point. The steamer then ascended the Monongahela as far as McKeesport, and then returned to Pittsburg, making a short run up the Allegheny and down the Ohio as far as the Davis Island dam. An interesting fact given on the program is that there are now loaded in the harbor of Pittsburg, formed by the Davis Island dam and in the pools of the Monongahela above Pittsburg, 1,000 coal barges containing 300 to 1,000 tons each, making a total of more than 875,000 tons of coal awaiting a freshet on the Ohio River to commence its journey to market. This is believed to be the greatest amount of loaded freight that was ever concentrated at one time and place. The day's excursion closed with a visit to the power station of the Pittsburg, Allegheny & Manchester Electric Ry.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The regular meeting of the society was held on Sept. 20, with 115 members and visitors present and President John R. Freeman in the chair. The larger part of the session was taken up with a discussion on reservoir embankments, with special reference to the break of the Mountjoy Hill Reservoir, Portland, Me. (Eng. News Aug. 17, 24 and 31) in particular.

Several causes were suggested for the break at Portland. The first and most important of these was the absence of collars, or cut-off walls, on the sloping overflow pipe laid through the embankment.

It was pointed out in the discussion that the 6-ft. concrete cube at the head of the pipe rested on a sloping puddle bank largely composed of clay, and that this puddle bank was for several weeks last winter subjected to unusually severe frosts by the partial emptying of the reservoir caused by certain accidents and delays to a new intake at Lake Sebago. The action of frost on a wet clay bank is well known, and it was suggested that undoubtedly the heaving of the concrete block by the frost loosened the joint between the block and the surrounding puddle; and, furthermore, that since the end of the pipe was firmly imbedded in this block of concrete, this heaving action tended to loosen the contact between the upper pieces of the pipe and the puddle surrounding it. Attention was further called to the fact that since this pipe was laid within a narrow trench it would be nearly impossible to ram that portion of the earth solidly which lay directly underneath the center of the pipe, and that if the earth under the pipe at about 45° up from the bottom was rammed hard, this might tend to wedge up the pipe and produce a slight void under the center. It appeared also that the experience of nearly everyone with ordinary street mains laid on a slope in wet ground is that when one digs down to them, a small vein of water is nearly always found following along the bottom of the pipe.

It was stated further that the testimony at the inquest was to the effect that the earth in the trench around this pipe was puddled and rammed by hand and with a greater proportion of water than that used in compacting the surrounding embankment and that therefore it was possible that a shrinkage or tendency to shrinkage would occur, thus loosening the grip of the earth about the pipe after the surplus of water used in puddling had evaporated. In line with this theory Mr. Desmond FitzGerald briefly described certain of his experiments on the shrinkage of damp earth upon subsequent drying, and stated that when making his experiments on evaporation at the Chestnut Hill Reservoir he had occasion to fill several large rectangular boxes with various kinds of earth, and that when he puddled this earth in, then allowed it to dry, cracks appeared between the earth and the sides of the box, in some cases half an inch wide. Mr. FitzGerald found that it was almost impossible to ram or compact wet earth into these boxes so that there would not be a subsequent shrinkage of the earth away from the sides of the box.

A very interesting discussion arose as to whether too much water was not generally used in compacting a reservoir bank, following the suggestions of Mr. FitzGerald's experiments. A letter was read from Mr. James H. Harlow, M. Am. Soc. C. E., of Pittsburg, Pa., recounting his experience in building several reservoir embankments where he had put them down dry, compacting them in thin layers very thoroughly by grooved rollers, but adding no water while rolling and acting on the theory that the bank would be tighter if water was kept away from it until after it was built, when the material was such as found in his vicinity, and that then when the reservoir was filled there would be a tendency to swell and tighten up. In other words, in building an impervious earthen bank he would follow the same principle that leads a carpenter to build a wooden tank of dry lumber rather than green, wet lumber. Mr. Harlow stated that he got this idea from Mr. Chas. Hermany, of Louisville, Ky., and a letter from Mr. Hermany was read detailing his practice in this regard. Mr. Hermany stated that he conceived this idea in 1876, but did not fully carry it out in practice until 8 years later.

The discussion as to how the terms "clay" and "gravel" could be more closely defined brought out a letter from Prof. N. S. Shaler, stating that this question had bothered him for the last 25 years, and that he was now at work on an apparatus designed to give closer numerical values to the distinctive qualities of clay and gravel.

In this same connection Prof. Robert H. Richards suggested that the "Fall Tube" used in metallurgical processes for grading the fineness of pulverized ores would no doubt have a very useful application in defining the qualities of clays, sand and gravel. This consists of a long glass tube into which the earthy mixture is poured and a current of water at any desired velocity is then caused to circulate from the bottom toward the top. This jet of water permits the particles to rearrange themselves, the finest at the bottom and the coarest at the top of the tube, separating the different grades with great distinctness. Professor Richards sketched out a modification of this tube for giving a numerical value to different grades of fineness of particles of clays and very fine sands, stating that definition of size of particles by means of sieves failed when the material got much finer than particles of 1-120 in. in diameter, and that many clays and sands were much finer than this. In response to a question as to whether there was any mechanical distinction in the form of the particle which caused the difference between clay and sand as a material for making embankments watertight, Professor Richards stated that certain researches had indicated that the ultimate particles forming clay were flat and scale-like in form instead of being nearly spherical or cubical, as was the case with worn or crushed quartz or sand.

A communication from Clemens Herschel, M. Am. Soc. C. E., was read, in which he advocated putting a bank down moderately wet, rather than dry, on account of the greater certainty of getting uniform work from ordinary unskilled laborers when water was used, although he did not doubt but that earth could be rammed quite as compactly dry as wet. In regard to the comparative merits of clay and gravel for making watertight work Mr. Herschel stated that he much preferred good gravel, and said that a clay bank at the site where a watertight bank was to be built should be regarded as an impediment rather than an advantage. There was nothing which could be done with clay in forming an embankment which could not be done better with gravel. Clay was one of the worst materials which could be found for filling coffer dams. In substantiation he referred to the Holyoke Canal embankments, which were of loose, pervious sand and river silt and rested on river silt, but soon became tight. A line of sheet piling was needed to steady the bank while it was new, but after 40 years this sheet piling, having become largely decayed, the banks still remained tight, their inner portion having become silted up or the filtration clogged. Mr. Herschel said further regarding masonry cores in earth dams that he could not see any rational objection to their use, and presented a gravel reservoir dam with a masonry core as the fin de siecle American type.

Prof. Wm. Watson spoke briefly of the Torcy-Neuf Reservoir dam for feeding the Central Canal in France, described on p. 613 of the report of the U. S. Commissioners to the Paris Exposition. This dyke is 64% sand to 34% clay, 1,200 ft. long, 18 ft. wide on top, with a maximum height of 53 ft., and impounds 2,310,000,000 gallons of water. The bank was put down in layers about 4 ins. in thickness, which were compressed 25% by rolling vigorously with corrugated horse rollers weighing 1,650 lbs., and steam rollers weighing 5½ tons. Water and powdered lime, according to the degree of dampness of the earth, were sprinkled over the loose earth just prior to rolling.

The topic was found so full of interest that by a

very general request the discussion will be continued at the next meeting.

During the afternoon an excursion of about 40 members was made to the outfall sewer of the new Metropolitan system at Deer Island and to the Shirley Gut siphon, which is just being laid. The sewer crosses Shirley Gut by means of a siphon of wrought iron pipe 100 ins. in diameter, with 12 ins. of brick work laid inside the iron. The top of the iron pipe will lie about 2 ft. below the bottom of the channel. The pipes are built on land in sections of about 60 or 70 ft. in length, the brickwork is inserted, and then they are floated into place and sunk and bolted together by divers.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting on Wednesday evening, Oct. 4, a paper on "The Storage and Pondage of Water" was presented by Mr. J. P. Frizell, M. Am. Soc. C. E.

The paper opens with a statement of the stream flow in Massachusetts, showing that 49% of it occurs in the three months of February, March and April, and but 9% in the three summer months and 14% in the autumn months. Extra high water is later in northern New England and earlier in southern New England. An establishment running throughout the year and depending wholly upon water power cannot use more than 2% of any part of the stream in more than one month, or more than 24% in a year; and even with this use of water it would be exposed to more serious interruption than would thus appear. In August and September the flow would naturally be below the average half the time, and often below 2%. In June and October, also, though the flow is 4% or 5% upon an average, there would be many days on which it would be below 3% and even below 2%. The percentages represent the flow for a series of years. Several years will occur sometimes in succession falling 25% to 50% below the average. No rational use can therefore be made of water power in modern industry without steam power to supply deficiencies in dry seasons, or storage reservoirs to hold back the surplus from high water for use in time of scarcity. With reservoirs it is possible, though hardly practicable, to make use of the entire flow of the stream. It is not worth while to introduce a steam plant to a greater extent than can be kept in operation for at least three or four months in an average year. This necessarily leaves large volumes of water to run to waste. The use of steam power does not preclude the profitable use of reservoirs.

In a table given, the value of reservoirs for use in connection with steam is computed. The elements of this computation are: 1. The quantity of water expected month by month and year by year from a given extent of drainage ground. 2. The quantity of steam power required to make up the deficiencies and maintain a constant total. 3. The change in the relative proportions of water and steam consequent upon reservoirs of different sizes. 4. The cost of steam power.

The saving in steam power that can be effected by reservoirs determines the amount that can be judiciously expended in the construction of the latter.

It is assumed that the observations made during the last 30 years on the Cochituate drainage and 19 years on the Sudbury drainage can be allowed, without serious error, to similar areas in New England. An establishment on a stream of 500 sq. miles drainage area, with a fall of 15 ft., and a requirement of 1,000 HP. to be furnished in that extent, both with water wheels and steam engines, the water to be used continuously during 24 hours, is also assumed.

The table given shows an enormous fluctuation of the stream. The month of March, 1877, furnished 9,973,000,000 cu. ft.; September, 119,000,000. During March the flow would have run 30 48-in. Rodney Hunt water wheels at full gate. In September a single wheel could hardly run at half gate. In 1877 the highest monthly average exceeded the lowest 80 times. In 1889 the highest monthly average is only a little over four times the lowest. Table 3 gives the average steam power required each month to supplement the water power, in order to produce a total of 1,000 HP. Table 4 shows the effects of reservoirs of different sizes upon the quantity of water available for power. Tables 5, 6 and 7 show the amount per month of steam power required for reservoirs of various sizes, in accordance with Table 3. Table 8 is a summary of the whole, being the cost of the steam power each year under various conditions.

The paper quotes Charles E. Emery, M. Am. Soc. C. E., as to the cost of steam power, and, making an increase on account of greater cost of coal, fixes it at $31 to $32 per HP. per annum, or 10 cts. per working day, or 1 ct. per hour. This is for an engine running constantly at full load, but an engine used for supplementing a water power works under much less favorable conditions; running unloaded it would indicate some 30 HP., and require the consumption of 6 lbs. of coal per hour. Wages have also to be paid. For these and other reasons the cost of steam per horse power per hour the writer fixes at 1¼ cts.

The annual saving consequent upon a reservoir as finally deduced from the tables will be for a:

Capacity of 3,000,000,000 cu. ft.	$11,393
" of 5,000,000,000 cu. ft.	16,717
" of 10,000,000,000 cu. ft.	24,221

This shows that the benefit of reservoirs to a single establishment or one mill privilege will hardly ever warrant the expense of their construction. At least 100 ft. of available head is required to make a project feasible, unless there are exceptional conditions.

If we suppose six establishments on a stream with an aggregate fall of 90 ft., the aggregate saving would be:

For a 3,000,000,000 reservoir	$68,359
" 5,000,000,000 "	100,301
" 10,000,000,000 "	145,323

The cost at which such reservoirs would pay a 10% interest would be respectively $228, $201 and $145 per 1,000,000 cu. ft. Reservoirs can usually be built in New England valleys at the higher of these rates, but the lower rate would seldom be possible. If we suppose an aggregate fall of 150 ft., a case by no means unusual, interest of 10% would be returned on costs respectively of $380, $334 and $242, and such results would be readily obtainable. Such figures answer the question whether water power has had its day and is necessarily going out of use.

used in a 30-year period, a mill using 500,000,000 cu. ft. a month, or about 200 ft. a second, exclusive of wastage. month, or about 200 ft. a second, exclusive of wastage. would have been short of water 63 times. It would have used in this time about 168,000,000,000 cu. ft. as against 483,000,000,000 cu. ft. which could have been used had the power been supplemented by steam, or approximately three times as much. A comparison is next made between a mill using steam and water power, and one using steam alone. The cost of the water power for 1,000 HP. is placed at $80,000, and the cost of steam at 20% more for a constant power. Allowing for interest at 5% payment to sinking fund for renewal in 30 years, and for maintenance and care, the cost for power for a year would be $43,350. The cost for steam for 308 days, 24 hours, at 1 ct. per hour per horse power, would be $73,920. The last would have the advantage of heating the mill by the waste steam during the winter, but the cost would still exceed that by the combined power. The tables also throw light on the subject of the absolute cash value of a water power. The difference in cost of steam power alone or steam and water power combined ought to be a measure of the value of the water power. In the case just cited, if $6,000 be assigned as the value of the heating power, there would still remain $24,561 as the annual value of the water power, and the mill could afford to pay this sum annually for its use.

Hardly less important than the storage of flow waters is that of pondage or the retention of the flow of a stream during non-working hours, for use during working hours. Many establishments, such as textile mills run only during daylight. An establishment running but 10 hours a day must be organized on a totally different basis from one using the same quantity of water and running continuously. All buildings, machinery, boilers, engines, water wheels, raceways, etc., must be about two and a half times the size, and pondage (in the case considered) must be supplied for 14 hours' flow, or about 37,500,000 cu. ft. Practically the mills use what pondage they have, and allow the night fall to run to waste. The flow of Sundays and holidays runs to waste, and to avoid all waste we should ordinarily have to hold the flow for about 40 hours, requiring 115,000,000 cu. ft. In this connection two tables are given showing the value of pondage under certain conditions, based on the same drainage area as the previous ones.

For a mill running 10 hours per day, stopping one hour at noon, making a comparison with the cost of steam power is equivalent to the gain from the pondage. The last table shows the average saving in steam power. For 30 years for pondage of 10,000,000 gallons it was $8,240 per year, and for a pondage of 20,000,000 gallons, $10,918, and the results would be increased with an increased amount of water used. In the case of a series of mills running 10 hours per day and supplied by storage reservoirs, it often happens that the daily discharge from the reservoir does not reach the mill within the working hours, and more or less pondage is necessary in order to avoid waste. No greater amount is necessary than would be required to make an equally complete use of the natural flow of the stream; generally it is less. In the case of a series of mills occupying different falls on the same stream, the pond of each mill reaching to the dam of the next above, it is sometimes advantageous to provide a large pond at the head of the line; each mill then draws from its own pondage until it receives water from the next above, and a single pond serves the whole series. This is the case at Gardiner, Me., where there is a pondage area of 215 sq. miles, and there is a storage capacity of 2,500,000,000 or 3,000,000,000 cu. ft. with a pond at the head of the series of dams capable of holding the discharge of the reservoirs while the mills are stopped, usually only on Sundays or holidays.

The most fortunate condition is where the same basin serves for both storage and pondage, as at Rockville, Conn. Shenipsit Lake, at the head of the river, has a drainage of 15 sq. miles controlled by a dam to the extent of 24 ft., and below the dam is a series of mill privileges with an aggregate fall of 250 ft., and a very small pondage is required for each dam. As soon as any mill begins to draw from its pond the mill above begins to discharge into the same, and very little water runs to waste. The construction of a system of storage reservoirs in the common interest of a number of mill owners requires a concert of action and a spirit of mutual concession and accommodation among the parties very rarely met with. Mutual jealousies and bickerings usually prove fatal obstacles to such projets; hence it is customary and advisable for the parties in interest, before beginning such an enterprise, to appoint a Board of Arbitration empowered to apportion the expense, and to adjust all questions between the parties.

The secretary announces that the proceedings of the International Engineering Congress and of the Convention will be published in the July "Proceedings," which members will receive early in October. It has been decided by the Publication Committee that the papers from Division "A" of the Congress shall be printed in the monthly numbers of the "Transactions" beginning with that for July. Every member of the Society will receive these free of cost, as quickly as they can be issued. When all printed, they will make two large volumes. The separate numbers can be purchased by other than members at $2 each, and the separate papers at one cent per page, with an additional charge for plates according to their size. The usual discount will be made to members desiring extra copies.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 7. Secy., L. F. Rondinella, 1122 Girard St.

DENVER SOCIETY OF CIVIL ENGINEERS.
Oct. 9. Secy., F. E. King, Jacobson Block.

ENGINEERS' CLUB OF KANSAS CITY.
Oct. 9. Secy., Waterman Stone, Baird Building.

WISCONSIN POLYTECHNIC SOCIETY.
Oct. 9. Secy., M. F. Schinke, City Hall.

CIVIL ENGINEERS' CLUB OF CLEVELAND
Oct. 10. Secy., F. C. Osborn, Case Library Bldg.

NORTHWEST RAILROAD CLUB.
Oct. 10 Secy., W. D. Crosman. Ryan Hotel, St. Paul.

NORTHWESTERN SOCIETY OF ENGINEERS.
Oct. 10 Secy., D. W. McMorris, Burke Block, Seattle, Wash.

INTERNATIONAL IERIGATION CONGRE-S.
Oct. 10-14. Los Angeles, Cal. Arthur L. Thomas, Salt Lake City, Utah, Chairman National Executive Committee.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Oct. 11. Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
Oct. 11. Secy. F. M. Curtis, O. C. R. R., Boston.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Oct. 12. Secy., C. H. McLeod, Montreal, P. Q.

ENGINEERING ASSOCIATION OF THE SOUTH.
Oct. 12. Secy., W. G. Kirkpatrick, Nashville, Tenn.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Oct. 12. Secy., F. W. Mowbray, Norton Building.

AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.
Oct. 12. Chicago, Ill. Secy., C. A. Hammond, 350 Atlantic Ave., Boston, Mass.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Oct. 13. Secy., D. W. Meeker, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Oct. 14. Secy., G. O. Foss, Helena.

WESTERN RAILWAY CLUB.
Oct. 17. Secy., Clement F. Street, Chicago.

COLUMBIAN ENGINEERING SOCIETY.
Oct. 17. Secy., F. W. Hart, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Oct. 17 Secy., R. H. Clark, Pittsburg

INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17-19. Annual Convention at Continental Hotel, Philadelphia. Secy., S. F. Patterson, Concord, N. H.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Oct. 18. Secy., S. E. Tinkham, 36 Broomfield St.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 18. Secy., L. V. Carmalt, Roanoke Va.

AMERICAN STREET RAILWAY ASSOCIATION.
Oct 18-20. Annual Convention at Milwaukee. Secy., Wm. J. Richardson, Brooklyn, N. Y.

ENGINEERS' CLUB OF ST. LOUIS.
Oct. 18. Secy., Arthur Thacher, Odd Fellows' Building.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Oct. 18. Secy., F. Collingwood. 127 East 23d St., New York.

NEW YORK RAILROAD CLUB.
Oct. 19. Secy., John A. Hill, Temple Court, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
Oct. 19. Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Oct. 19. Secy., Allen Strale, 100 Washington St.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Oct. 20. 201 Washington Building.

SWEDISH ENGINEERS' CLUB.
Oct. 21. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Nov. 6. Secy., C. L. Annan, City Engineer's Office.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Nov. 7. Secy., W. Halliburton.

WESTERN SOCIETY OF ENGINEERS.
Nov. 8. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
Nov. 9. Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Nov. 10. Secy., F. K. Smoot, 306 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 10 Secy., O. Von Geldern, 719 Market St., San Francisco.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov 16. Secy., S. A. Cherpiot, Macon, Ga.

CENTRAL RAILWAY CLUB.
Nov. 22. Secy., H. W. Spear, Buffalo, N. Y.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon: new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering Headquarters at Chicago are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

The sale of street railway franchises in New Orleans 13 years ahead of the expiration of these franchises, in 1906, causes the "Times-Democrat," of that city, to editorially take up the value of street railway franchises. The sum paid was $700,000 cash, which is estimated as equivalent to the payment of $1,246,000 for immediate possession, as the purchaser must issue bonds for the $700,000 and pay interest upon these for 13 years before it obtains what it bought. Our contemporary argues that this is more than the franchises are worth, as they grant privileges only on certain lines, and that the natural growth of the city will give birth to powerful rivals which will divide the business before the expiration of the 50-year lease, in 1956. The question of relative compensation can only be determined upon data not here available, but from other parts of the same editorial it is evident that a change was urgently required in the prevailing New Orleans street railway practice, and it is safe to say that the parties making the offer have carefully considered the prospective profits to be derived from a change from mule to electric traction and the replacing of bad track and shabby cars by a better general plant. It is a law recognized by progressive transportation companies that the more attractive and comfortable the conditions of travel are made, within certain commercial limits, the greater will be the traffic and the resulting profits. Rough, badly kept track, dirty cars and irregular service neither invite traffic nor insure big dividends; and while we believe in the city obtaining a fair share of the profits for the street privileges granted, the city authorities should pay even more attention to the character of the service afforded to the traveling public. In other words, it is better that the transportation companies should be made to expend a large part of their profits in improving the conditions of traffic and the comfort of the traveler rather than to give up even an equal sum to the city with the public convenience ignored. As a rule in the granting of franchises in the United States, the city receives no compensation other than the license fees or a tax upon individual cars. The sum received from these sources is comparatively insignificant, and the tendency of the tax is to restrict the number of cars rather than to meet the growing demands of traffic. But, when these valuable franchises are put up to the highest bidder, as is the later practice in large cities, it is also too often the rule to pay entirely too much attention to the amount of the bonus to be paid and to almost entirely ignore the first demands of the public in the character and convenience of the service to be rendered by the transportation company. In all such cases the rights of the whole community using the street railways should be first considered, and considered as travelers rather than as taxpayers.

The latest conspirator against the peace and happiness of mankind is an electrical inventor who has appeared at the World's Fair with a fully developed scheme for turning the clouds into billboards. He appears to have been taken up most enthusiastically at Jackson Park; and if we may believe some of our enterprising electrical contemporaries who always sing praises of all things electrical, the visitors at the Fair will be startled some night before long by seeing a portrait of Christopher Columbus displayed on the clouds over their heads, followed by the visages of the principal World's Fair officials. The inventor is said to have secured the use of one of the 44-in. searchlights; and he is to be aided and abetted in his nefarious scheme by the construction of artificial clouds of smoke or steam, in case the indignant heavens refuse to furnish real clouds.

If this inventor's misdirected ingenuity is rewarded by the success which it does not deserve, we may expect to see the placid clouds of a summer evening displaying such legends as "Drake's Delightful Dentifrice," "Buy Your Boots of Smith," or "Have You Used Plum's Soap?" It will then be necessary to form societies for the prevention of the disfigurement of the sky, and to agitate for legislation forbidding under heavy penalties the manufacture and use of cloud projectors. It was bad enough to have the scenic grandeur of mountains and valleys disfigured by the paint brush of the unscrupulous advertiser; but to emblazon on the heavens themselves the wares and nostrums which the world does not want is little short of a capital crime. The inventor who has so misapplied his ingenuity should be given the alternative of immediate reform, or subjection to some such cruel and unusual form of punishment as frying in his own search-light.

Mayor Latrobe, of Baltimore, Md., is making a vigorous effort to secure for that city the valuable and most interesting historical exhibit of the Baltimore & Ohio Ry. Co., at the World's Fair. President Mayer, of the Baltimore & Ohio company, has promised to donate this collection of originals, full-sized models, drawings, etc., gathered together with much labor by Maj. J. G. Pangborn, as the nucleus for a museum of railways, and Mayor Latrobe wants the city of Baltimore to donate the ground and believes that the citizens will readily raise the $30,000 required for the first buildings. Such a museum would be unique in its way and would be the means, no doubt, of preserving for other generations much of historical interest in connection with the railways of this country that would otherwise be lost simply for the lack of some suitable place of deposit.

But we would suggest that a still better disposition of this collection would be to donate it to the National Museum at Washington. The end in view is one that would make it eminently proper for Congress to provide the means for properly housing it, and under the auspices of the national government there is a much better chance of extending it and of increasing its general usefulness. Mr. Watkins, of the National Museum, has already made a beginning in a historical collection of railway appliances, and well directed efforts could doubtless add largely to this from the native and foreign exhibits at the World's Fair, other than that of the Baltimore & Ohio company. Relics of great historical value and types of construction now obsolete, but interesting as links in the chain of experience, abound in private hands, and they should be gathered together as invaluable object lessons. And this can be done if some decisive step be taken by Congress, proving to the public that our government has a really live interest in what more than anything else has made our country great.

According to press accounts, the unexpended balance of the appropriation made by the Canadian Government for sounding and boring on the line of the proposed Prince Edward Island Tunnel is being utilized in search of further information of this character. While this information is interesting from a geological standpoint, and Mr. Alfred Palmer, as shown in our issue of June 29, 1893, displayed great ingenuity in making these borings in depths of water up to 100 ft., it is a serious question whether it will ever pay to build a tunnel at this point. It certainly will not pay now to thus connect with the mainland an island containing a population of considerably under 200,000 and having a very insignificant trade of any kind. It is true that one of the conditions upon which the Prince Edward people entered the Canadian Confederation was that a continuous communication was to be provided, winter and summer, with New Brunswick. But if the redemption of this pledge means the construction of an 8½-mile tunnel at a depth of 120 to 160 ft. below the water surface, it would probably be cheaper for the Dominion Government to buy out the island. We have seen no estimate of ultimate cost; but judging from the financial difficulties encountered in driving a railway tunnel under the Hudson River between two such cities as New York and Jersey City, the promoters of the Prince Edward Island tunnel would have some trouble even in raising a sum sufficient to start with. The failure of the much more promising scheme of the Chignecto Ship Railway, with two-thirds the work done, is not encouraging to the Northumberland Straits' enterprise. And as far as continuous railway communication is concerned, there would be a conflict of gages; for the railways of New Brunswick are all standard gage and the 210 miles of railway on the island are all of 3-ft. 6-in. gage. We can fully appreciate the wishes of the people of this island to have winter communication with the mainland; but as they can never build a tunnel themselves, and there is little or no prospect of others building it for them, they had better content themselves with a fleet of powerful ferry-boats, which would cost much less and thus better invite capital. As we understand the situation, such a fleet, with landing piers extending beyond the shore ice, would be interrupted for but a few days even in the severest winters.

REVERSING LOCOMOTIVES IN EMERGENCY STOPS.

A paragraph has been going the rounds of the newspapers headed, "Reversing the Engine Makes the Train Go Faster." It started, we believe, from a reporter's interview with "an old New York Central engineer," who told the reporter that "it is a curious thing that reversing your engine at high speed makes the train go faster instead of slower. The reason is that the drivers slip and the locomotive shoots ahead as if it were on skates."

Unfortunately the engineer did not explain in detail the reason for this phenomenon, and conse-

quently many newspaper readers are probably puzzling over the question how turning the wheels backward can pull this train forward. What the engineer should have said—and it is a fact which is already very familiar to a good many of our readers, but which, perhaps, is still not so well known as it should be among engineers and railway men—is that where a locomotive is equipped with driver brakes it will stop more quickly with the brakes alone than it will if the engine is reversed after the brakes are applied.

The reason for this is readily explained, and we explain it at the risk of seeming to tell over again an old story. Whether the brakeshoes or cylinders be used to stop the train, the point at which the retarding force is actually exerted is the point of contact of the wheel with the rail. A train under headway is stopped by a backward pull of the rails on the wheel tread, which is just as real a backward pull as if it were exerted on a rope hitched to the rear car. Now, when this backward pull of the rails reaches a certain point, the wheel begins to slide on the rail; and both theory and experience unite in declaring that the rail exerts a considerably greater backward pull on the wheel when it is just on the point of sliding than when it actually slides.

Consider, now, the forces acting on a locomotive driving wheel when the train is running forward, and the driver brakes are applied and the engine is reversed and given full steam. The power of the cylinders exerts a force tending to turn the wheels backward, the grip of the wheel on the rail tends to turn them forward. Which way they will actually turn depends on which of these two forces is the greater; on an engine with ordinary cylinder dimensions and full boiler pressure, they will generally turn backward. Broadly speaking, however, these two contending forces are not far from equal. But the brakeshoe pressure acts not to turn the wheel in either direction, but to prevent it from turning at all. In other words, in order that the wheel may turn backward, the cylinder pressure must be greater than the grip of the wheels on the rails plus the friction of the brakes and the friction of the engine; or it can only turn forward if the grip of the wheels on the rail is greater than the force exerted by the cylinders plus the friction of the brakeshoes and of the machine itself.

It is apparent from this that if an engine is reversed with the driver brakes on, the wheels are bound to slide, no matter how much sand the engineer pours on the track; and it is, therefore, bad practice for an engineer to reverse after applying the driver brakes.

It may fairly be asked, however, whether a locomotive might not stop more quickly by reversing than by using the driver brake. With cylinder power sufficient to turn the wheels backward, it probably would do so if the engine was moving very slowly. It is true that a wheel turning backward on the rail has a lower coefficient of friction than the same wheel rolling on the rail without slipping; but if a locomotive be moving at five miles per hour and the cylinders have power enough to slip the wheels backward at a rate of 10 miles per hour (velocity of rubbing surface), then barring the difference in coefficient of friction, the time taken to stop would be inversely as the velocity of the rubbing surfaces during the stop.

But the time when the greatest braking force is desired is when the train is moving at high speed; and locomotives of modern design are not so overcylindered as to be able to slip their wheels backward very rapidly. Thus, while it might be possible theoretically to stop more quickly with the reverse lever under certain conditions, in practice the locomotive engineer should be instructed to rely on his driver brake for stopping and let his reverse lever alone. If the driver brakes are connected with the train brake and operated by the same handle, as they should be, a single movement of the runner's hand applies all the brakes with their full force, and there are no precious seconds lost in shutting the throttle, pulling over the reverse letter and opening the throttle again. In addition, the reversal of a locomotive at high speed is not unlikely to cause breakage at some point, or derailment, while practically no such dangers exist in the use of the driver brake.

The use of the reverse lever for stopping has become a habit with engineers from long years of experience before the days of driver brakes. The handbooks which are, perhaps, most consulted by engineers, Forney's "Catechism" and Sinclair's "Engine Running," were both written when driver brakes were little used, and both advise the use of the reverse lever in stopping. Now that the danger of the practice is clearly understood, however, superintendents of motive power should see to it that all traces of the old habit are eradicated among their engineers, and that they are properly instructed as to what to do in an emergency.

THE CHESTER BRIDGE DISASTER FINDING.

We publish in another column under this head a letter from Mr. Albert H. Howland, the original designer of the Chester bridge, under the late E. S. Philbrick. He desires to clear the structure from any suspicion of having been originally weak or defective in design. He does it, we think, effectually. We have never held any opinion to the contrary, and in saying, as we did, that the process which caused the disaster had "weakened the already weak bridge," we spoke only of its strength as compared with present needs. The mere fact that it was being strengthened shows that for these needs it was "already weak."

But, while we have pleasure in saying this much in justice to our correspondent, we feel bound to point out further that this letter furnishes a prompt and signal proof of the justice of our objections to the commission's report; namely, that although there are few or no single statements which can be affirmatively questioned, yet, because of the selection of what to say and what not to say, and because of the narrow lines of investigation to which it was confined, there is in effect a suggestio falsi" running all through the document (without the slightest intention, we are sure) which makes it in effect a mere white-washing document and misleads the inexpert reader most injuriously to the public interest.

The whole effect of the document, and especially of the parts quoted by our correspondent, is to inculcate that everything was all right and as it should be, except that an exceptionally reckless foreman had been guilty of the heretofore unheard of carelessness of "recklessly allowing" the weakening of the bridge to go too far; that the company for its part had made "reasonable provision" for strengthening the bridge (which distinctly implies all needful provisions which might have been foreseen, including proper inspection), and that its "confidence" in its contractor "was well grounded," but that, "as it proved," it was a "fatal" neglect or omission that it did not have an inspector on hand to guard against careless foremen and hence it must shoulder the responsibility for the accident. Of recognition that such bad methods of repairs and absence of inspectors was habitual and of many years standing, and had settled down into a regular practice, and this not only on the Boston & Albany, but on several other New England roads; of recognition that it was on its face not merely "serious," but most unusual and criminal quite apart from how it "proved" in result, there is not a word.

Nevertheless, such were and are the facts, as might easily be inferred in part from the testimony at the hearing, and as might easily have been shown in full by probing a little further and more generally. We have our own sources of information, and speak from a little more knowledge than was officially obtained by the commission. This is not the first time that we have done so, nor the second nor the third, by taking a little pains to ascertain the bottom facts on our own account. Thus we have been able to ascertain affirmatively that the same kind of criminal carelessness which was shown at Chester has been shown time and again on the Boston & Albany and other New England roads, differing only in result; and we will mention specifically certain bridges on the Central Vermont road. If any one in a position to know the facts ventures to question this, furthermore, we will undertake to prove our statements. We cannot, of course, undertake to prove the precise comparative degree of recklessness. That is past hoping for as to past events. It may be that never before was anything quite so extreme in recklessness done before, but we find no reason in the testimony to believe this, and we do not believe it.

For who that knows from experience the ways of under foremen—their timid caution in doing anything radically different from their instructions and from what they have seen done before, their easy recklessness in doing anything and everything which they have done or seen done with impunity, and, perhaps, going a mere trifle beyond this—will believe for a moment that this foreman, Belville, who had been for three years or so doing the same kind of repairing work for the same people, suddenly became so reckless as to depart very materially from what he had been taught to do and had done, or seen done? No sensible and fair-minded man who merely reads over the official testimony in this case will be able to force himself even to accept this as a possibility. Belville may, perhaps, have gone a little further than he had ever gone before; that is another matter; but in view of the old Latin maxim, i. e., "nemo repente turpissimus" (no one becomes a great scoundrel all at once), who can believe that Belville or any other human being suddenly became most reckless; suddenly jumped from three years' of good and safe work for the same master to such inconceivably murderous recklessness as he showed in this case?

It is true that this was the first bridge out of many which had been strengthened in which disaster actually followed, which raises a certain prima facie presumption that he and his fellows never before had gone quite so far; but is it not in evidence, as quoted in our correspondent's letter, that only a few minutes before the bridge actually fell under a passenger train a freight train had passed over it in safety while in precisely the same condition?

This fact, which is quoted by our correspondent as exculpatory (which it is for his immediate purpose, as proving the original quality of the bridge), is really a damning one. It shows that, measured by the only possible standard of the coterie of ignorant men who were in charge of this structure, that the danger line had been exceeded only by a hair. Suppose that passenger train had not come along? Would not the whole Belville-Reed gang have had a new demonstration that they were "safe" in stripping a bridge to that extent? Would they not be tempted to go just a hair further when some occasion arose on another bridge, and a hair further yet on the next one, and so on until disaster became inevitable under any train? Is there any other conceivable process by which a whole gang of ignorant men, having the timidity as well as the recklessness of ignorance, could be educated up to such a last extreme of recklessness with structures placed in their unchecked charge, as they actually showed?

Again, the supposition that there was anything materially exceptional in this disaster except the result is almost excluded by the fact that Belville was an old hand at the work; "for he'd been there before, many a time, many a time." It is conceivable, though most improbable, that an entirely green foreman on this particular kind of work might have entirely misconceived the nature and intent of his instructions and gone far beyond them in the way of recklessness, though he would have been far more likely to have been overcautious in breaking himself in to such work; but as he was an old foreman, so trusted that he had only the extremely general instructions and casual supervision sworn to by Reed (if even that), it is practically certain that he knew in advance about what was expected and did just that, as in substance he claims he did.

These things we say to make it clear that from the official testimony alone the same facts were easily inferable which we know and have stated from our own sources of information, and we know nothing but what any one might have ascertained by a very little probing. It is at least highly probable, in our judgment, that, frightfully weakened as it was, the bridge was yet really "safe" by the Belville-Reed standard against any one train. They know more than any engineer can ever know as to where that limit lay. "The grace of God and force of habit" often accomplishes miracles in keeping up weak structures, but the combination of a preceding freight train to weaken the structure and a

swiftly following heavier passenger train to finish it was an unusual one which may easily have been needed to give it the coup de grace, when no single train could have done it.

Let us descend now to some particulars. Our correspondent quotes from the commission's report that the bridge "had never shown signs of weakness"; that there had never been "occasion to report anything wrong except to ask for new ties"; that "there was no known defect, deficiency or want of repair"; that "it had given no signs of structural weakness or deterioration, and up to the present summer had not received or required alteration or strengthening." Supposing it had not; what of it? Could not precisely the same thing have been said in the same words of the now famous Bussey Bridge just before it fell? With a chief engineer who was not himself in any sense a competent judge of bridge plans or bridge practice (we feel bound to speak plainly), and yet who was not ashamed to turn his bridge engineer into a mere office draftsman and his contractor into a simultaneous inspector, and to make his own sole means of information as to the structure a lightning rivet-tapper who had "never learned the business of bridge-building," who reported to a carpenter who did not report to the bridge engineer, how could any knowledge of concealed defects in the structure, if it had ever so many, possibly filter through so many incompetents and become of record? We do not say nor believe that the bridge had such defects of any moment, but who can say with certainty that it had not? The rivet-tapper certainly could not, with any effect at least, for he swore to a transparent exaggeration which we exposed last week, and which might have been, but was not, exposed upon the spot; and Professor Swain, who inspected this bridge for the commission some years ago with all the other bridges in Massachusetts, would probably be the last to claim that such inspection could or did insure against anything but palpable and material defects. Such state inspection is neither adapted nor intended to be a substitute for company inspection, but only to safeguard the public against gross defects and negligence.

Why, then, such strong reiteration in the report of statements which mislead the public by seeming to say something while they really say nothing? We can easily surmise some motives, which do credit to the heart of the commission, if not to their judgment. They saw and felt that the accident was at best a reproach to Massachusetts and to their supervision, especially as it came so soon after the Bussey Bridge disaster, and they naturally desired to make clear the points of difference, and emphasize the fact that the structure was at least not inherently unsafe, but the contrary. They felt the usual good-natured pity toward the higher officers who had erred only from ignorance or laziness and not from criminal intent; and hated to hit a man when he was down. They felt also, perhaps, somewhat of the timidity of non-experts in proceeding from the concrete to the abstract, from the circumstances which actually caused a particular disaster, of which they could judge, to circumstances which merely might have caused one, of which they could not judge of their own knowledge, but only by balancing conflicting testimony.

But the result is nevertheless a public misfortune and wrong. Why was not the chief engineer put upon the stand? Why was he not questioned as to his reasons for placing such extraordinary confidence in a contractor; as to the extent of his own knowledge of just what that contractor did and just what that contractor knew about the strength of bridges? Why was he not questioned as to the extent of his own supervision of bridge plans and work and of his own knowledge of them; as to his reasons for making his bridge engineer a mere drawer of plans; as to whether he ever himself received and scrutinized any reports from the inspector who reported to the carpenter, or from the contractor, or from any other source, as to the actual state of his bridges and the methods of strengthening; and as to whether he himself knew just what those methods were? Why were not the precise limits of the responsibility and discretion which he understood he had confided in the contractor and which the contractor understood and admitted, determined by questions? Why was not the contractor himself questioned as to the extent of that knowledge of bridge-building and as to his practice in repairing other bridges, which had led the company to place that confidence in him which the commission go out of their way to assert was "well grounded"? Why were not the various underlings involved questioned minutely as to just what they had done on other bridges as well as this?

Had these and other questions which we might easily suggest been asked in earnest, a sorry record indeed of official incompetency and neglect, persistent, long-continued and widely ramifying, might easily have been brought to light. It should have been brought to light.

LETTERS TO THE EDITOR.

INSTRUCTION IN SURVEYING AT COLUMBIA COLLEGE.

Sir: Your report of the discussion on engineering education at the Chicago meeting of engineers has recently come to my notice, and I have been particularly interested in some criticisms by my friend Professor Merriman, of our manner of teaching surveying at Columbia College, as explained to the meeting by Professor Munroe.

I do not know in how much detail Professor Munroe described our methods, but it is evident that Professor Merriman has decidedly misapprehended our purposes and process. It is important to us at least that so well known an educator should have a correct idea of us, and that wrong impression should not be spread through your paper; hence this brief note, which I trust you may find space for in your columns.

Professor Merriman takes exception to our method of checking the work of the students on the ground, first, that the method employed does not represent actual practice, and second, that it was based upon the presumption that students would cheat in their work.

Concerning the first count, founded apparently upon our use of stone monuments with copper bolts as definite stations for drilling the students in handling the transit and steel tape, it is certainly true that the engineer, in after practice, will not find such monuments planted for him in the swamp or on the hillside. I do not think, however, that the student is any the less qualified by this drill for setting up over a wooden plug, of which, by the way, we use up in the thousands during the season, and the practical success of our graduates in instrumental work indorses my opinion.

It is proper to add also that all this is only one phase of our work, to which I feel sure that in the main even Professor Merriman would not take exception on the score of its practicality.

Now, concerning the second objection to our system of checking the student's work, we must plead guilty to using a considerable part of the time of the seven or eight instructors in working up and maintaining this very system of checks, and I can only add that I would sacrifice almost any other feature of the school before I abandoned it. To it our school of surveying owes a very large proportion of what thoroughness and excellence it possesses. If Professor Merriman or any other interested person will favor us with a visit I will undertake to convince him of the importance of this system to us and of its entire harmlessness to the personal dignity or pride or sense of honor of the students. In fact, its purpose is not, except as it may be incidentally and probably in a few cases only, to prevent cheating. That it would most effectively stop that if occasion required is only a point in its favor.

Its primary function is to enable the officers to know precisely the quality of work that each squad of two students is doing, and to drill them until they can themselves understand what good work with transit, tape or level means and appreciate their own probable amount of error. This object is attained, and thoroughly attained, by our system of checks, and we consider it a vital feature of our methods. Moreover, even the honorable, earnest student, typical, I am glad to say, of the great majority, is much more likely to do his best if he knows that his report is to be rigorously compared with official angles, azimuths, distances and elevations, and thus a high standard of work can be readily obtained.

It never occurs to our students that this examination is any humiliation or casts a slur upon their honor any more than a classroom examination, to which, indeed, it bears some analogy.

No, I cannot feel that Professor Merriman has caught correctly the aims and methods of our summer school of surveying, and once more I extend to him and others interested a hearty invitation to visit Camp Columbia and see for themselves what a self-respecting and respected body of earnest students our system of instruction brings together.

Very sincerely yours,
James L. Greenleaf.

Camp Columbia, Morris, Conn., Aug. 18, 1893.

THE CHESTER BRIDGE DISASTER FINDING.

Sir: The editorial in your issue of Sept. 7 on "The Last Great Bridge Disaster" (namely, that at Chester, on the Boston & Albany R. R. on Aug. 31) refers to the bridge as "aged, re-tinkered structure," as "old and infirm" and as "already weak," and you intimate that the indications point to faulty design as the probable cause of the disaster.

The information at your disposal at the time of writing no doubt justified you in expecting that such a conclusion would be reached. The facts, however, as brought out by the Railroad Commissioners' investigation and report just made (printed in these columns in full last week.—Ed.) must show you, I think, that the bridge, so far from being fairly characterized by the terms you provisionally used, was an excellent one.

From the Commissioners' investigation and report it appears that the bridge "had never shown signs of weakness;" that there had never been "occasion to report anything wrong except to ask for new ties"; that "there was no known defect, deficiency or want of repair"; that "it had given no signs of structural weakness or deterioration, and up to the present summer had not received or required alteration or strengthening"; that "the bridge, as originally built (in 1874), was a safe bridge, of sufficient strength for all the traffic which has been done over it up to the time when the recent work was begun"; that passenger engines with 53 tons on six drivers had been in use over it; that it was being strengthened to bring it up to the company's standard for new bridges, in anticipation of using consolidation engines having 50 tons on the drivers; that the strengthening of the top chord was being done by adding cover plates; that in the progress of this work and at the time of the disaster the cover plates, both old and new, of the top chord, "for a length of 25 ft. or more, were not fastened to the chord or to each other by either rivets, bolts or drift pins," but "had slipped off from the chord as the truss was canted over and were lying in the river bed"; that the lateral braces were wholly disconnected from the top chord at three or four panel points along the same part of the truss; that "the bridge had thus been radically and fatally weakened," so that the chord "could support but a small fraction (for a guess, I should say a quarter) of the compressive load which it would be capable of sustaining if the top plates were firmly riveted down"; that "these facts indicate beyond the possibility of a doubt the cause of the disaster"; that "no further explanation is needed"; and, finally, that, while in the condition described, it carried a freight train safely over and fell under a passenger engine (with 107,000 lbs. on its drivers) and its train, running 30 miles per hour. Doesn't it deserve to be well spoken of?

For several years about the time this bridge was built the Boston & Albany was replacing its bridges with iron ones; the work was in charge of the late E. S. Philbrick. I was his assistant on the work and was responsible to him for the sufficiency of the designs.

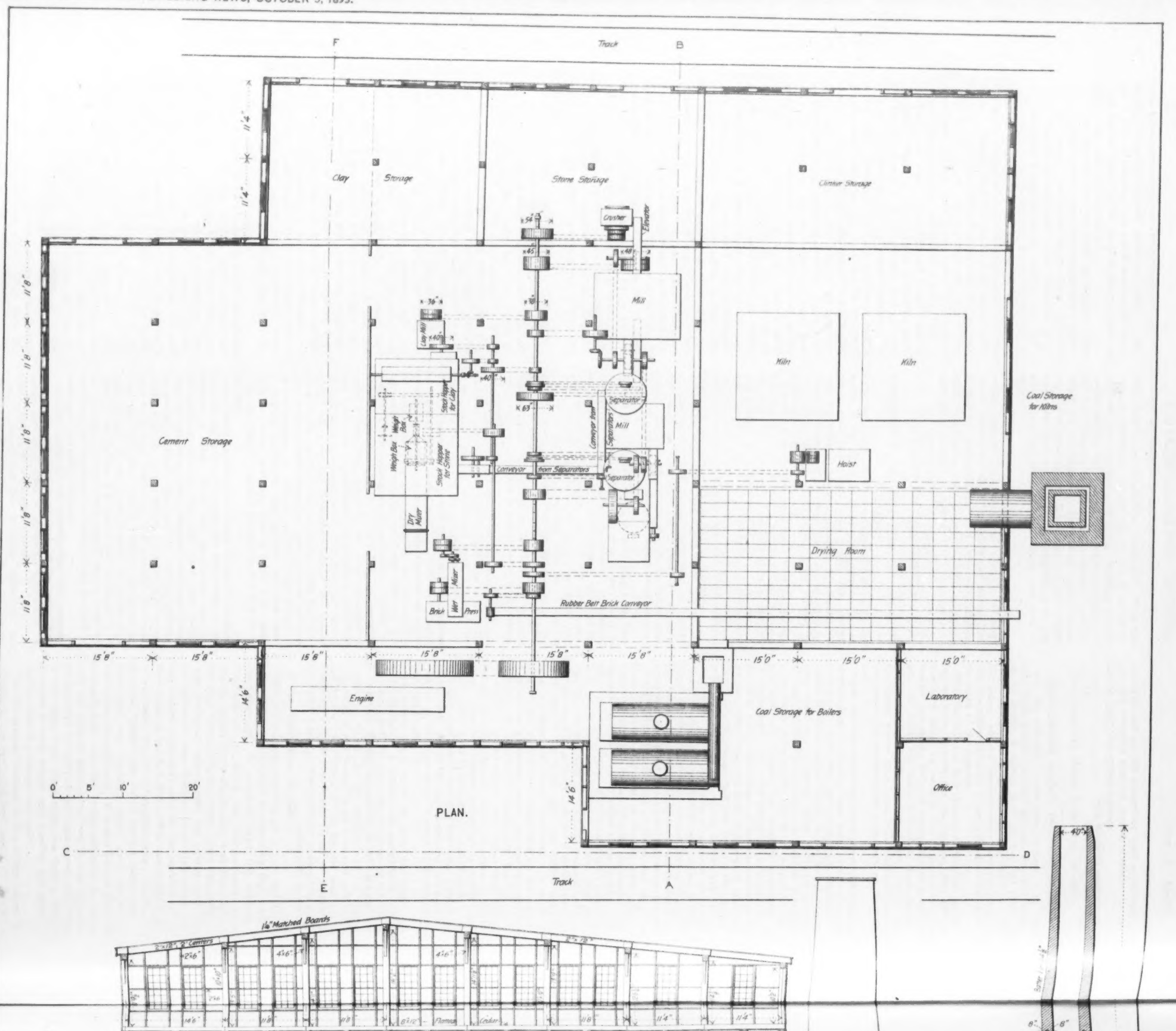
In fairness and justice to all concerned and to the end that the real lesson of the disaster may not be obscured, I think your record should be amended in the light of present developments. Respectfully yours,

Albert H. Howland.

Boston, Mass., Sept. 26, 1893.

(We never state anything as a fact merely because we feel "justified in expecting that such a conclusion will be reached," and the expression "re-tinkered," to which our correspondent justly objects under the circumstances, was due solely to the fact that in all the earlier press dispatches it was distinctly stated that the bridge had been strengthened once before. It is now clear that this report originated only in the renewal of the floor about a month before, which was really a part of the same process of strengthening. As for the rest the bridge was "old," having been built in 1874, and was "already weak" or it would not have been strengthened. It is now alleged that this strengthening was only with reference to future and not present necessities, but in any case the bridge was "already weak" compared with what it was when built, since there has been a decided increase in both weight and number and speed of trains since the bridge was built.

As the original designer of the bridge under Mr. Philbrick, our correspondent naturally objects to any shadow of unjust reproach in regard to the original design of the bridge, and we are happy


F
Track
B
Clay Storage
Stone Storage
Clinker Storage
Crusher
Elevator
Mill
Kiln
Kiln
Coal Storage for Kilns
Cement Storage
Clay Mill
Stock Hopper for Clay
Weigh Box
Stock Hopper for Stone
Cement from Separators
Separator
Separator
Mill
Conveyor from Separators
Hoist
Dry Mixer
Drying Room
Wet Mixer
Brick Press
Rubber Belt Brick Conveyor
15'8"
15'8"
15'8"
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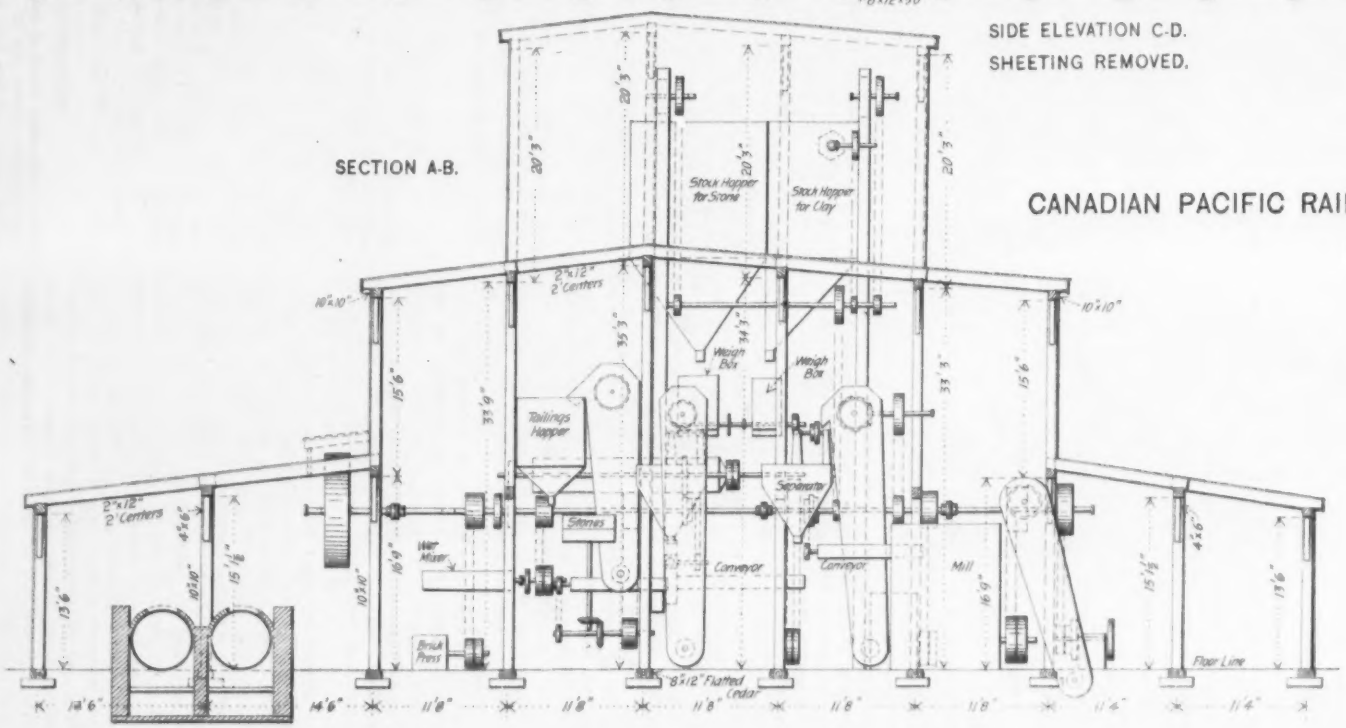
15'0"
14'6"
Engine
Coal Storage for Boilers
Laboratory
Office
0' 5' 10' 20'
PLAN.
C
D
E
A
Track
1½" Matched Boards
2"x12" 2' Centers
8"x12"x30' Cedar
Planks
Cedar
40'
8"
8"

SECTION E-F.

SIDE ELEVATION C-D.
SHEETING REMOVED.

SECTION A-B.



CANADIAN PACIFIC RAILWAY PORTLAND CEMENT WORKS,

FALSE CREEK, VANCOUVER, B. C.

Designed by

J. S. Rigby & Co., Engineers,

Wavertree,

England.

CHAS. HART & SONS, LITH., 30 VESEY ST., N. Y.

to be able to relieve him of it. The facts brought out at the investigation seem to establish that it was, when erected, in 1874, of good design and ample strength, and that its failure had no connection whatever with any defects of original design or workmanship. It appears to be affirmatively established that the bridge was perfectly safe even for present train-loads in its normal condition, and certainly there is nothing to indicate the contrary. We have at no time intentionally implied the contrary, and certainly have not asserted it. The one word in our former comments which we should wish to alter in view of later developments is the word "re-tinkered," as above explained. What further we have to say with reference to this letter appears in another column.—Ed.)

IRON BRIDGES VS. TORNADOES.

Sir: I think "T. C." is mistaken, referring to the destruction of the Kansas City bridge in 1886 (Eng. News, Sept. 21), in speaking of it as "a wooden combination truss of an unsatisfactory design." It is my recollection that this span was about 150 or 175 ft. long, of iron, and an examination of the ground just after the storm showed the masonry piers almost intact, except on one corner, from which I inferred that the bridge must have been lifted bodily and carried sideways until clear of the masonry. The bridge was one of the first built over the Missouri, and was constructed under the direction of Mr. O. Chanute.

In this storm, which occurred May 12, 1886, 2½ ins. of rain fell in 25 minutes. K. A.

Yonkers, N. Y., Sept. 28, 1893.

(We find the following mention of this accident, confirming K. A.'s statement as to the lifting of the bridge, in the "Railroad Gazette" of May 14, 1886.—Ed.)

In a tornado which struck Kansas City, Mo., on May 11, the second span from the north end of the bridge over the Missouri opposite that city was blown into the river, the piers being left apparently uninjured. The span, which was carried away, is a complete wreck, and it will take some time to repair the damage. The bridge is used by all the railway lines entering the city from the eastward except the Chicago & Alton and the Missouri Pacific.

VACUUM BRAKES ON THE LONG ISLAND R. R.

Sir: In your comment on the Long Island R. R. brake equipment, in your issue of Sept. 21, you say that "at present all but four of the Long Island cars proper are equipped with Westinghouse brakes, and the four which still have the vacuum brake are running in service where a brake failure would be unimportant." It would be interesting to know where you draw the line, but, however that may be, the writer has to-day seen vacuum brake equipment on regular first class passenger express service on the North Side Division of the Long Island R. R. It is possible that this being a branch, the cars thereon are not Long Island cars "proper"; nevertheless, these trains use the Long Island city terminal station, and run on main line tracks, interspersed with other trains, for several miles, and the North Side local service is as important as any other.

For several years past Westinghouse brakes have been used on the main line trains, but the cars in use on the North Side, on which there are upward of 50 passenger trains each day to Whitestone, Flushing, Great Neck, etc., are for the most part, as the writer believes, still supplied only with the vacuum brake. This is not a criticism on the fact, but on the misleading statement in your columns which a visit to Long Island City would enable you to correct. The North Side trains run from Long Island City to Woodside Junction on the same tracks and schedule as main line trains, and if your representative would proceed on one of them to that point he would not only find food for thought in contemplating that lay-out, but would conclude that a brake failure on this part of the line could not be "unimportant." Experience.

New York, Sept. 25, 1893.

(We regret that we did not make our original statement more explicit, as it appears to have misled our correspondent. The facts of the case are, as stated to us by Mr. Prince, Superintendent of Motive Power, that the entire Long Island passenger car equipment, including the North side division, is now equipped with the Westinghouse brake, with the exception of four cars, which are run as shuttle trains on short branches at low speed. It is quite true, as our correspondent states, that many of the cars run in first-class passenger service are still equipped with the vacuum apparatus. In changing the system of brakes, it was necessary to leave the vacuum apparatus on the cars until all were supplied with the Westinghouse equipment, so that a train made up with a car or cars having only vacuum equipment could be worked on that system. On the North Side division, to which our correspondent especially refers, the change to Westinghouse equipment was completed in May last, but the vacuum apparatus still remains on many of the cars, and will remain until there is an opportunity to bring them to the shop.—Ed.)

TRANSITION CURVE FIELDBOOKS.

Sir: Is there a work which gives a good, every day practical method of laying out transition curves? I see several advertised, but I fear that they are made up in some professor's study and not in the field.

I would consider it a great favor should you give me an early answer. Yours truly,

A Reader of Engineering News.

Northfield, Vt., Sept. 20, 1893.

(We cannot undertake to distinguish between them, except to say that what we regard as a really satisfactory system has not yet been embodied in any fieldbook known to us. Any truly satisfactory and proper system will admit of using any offset (and consequent length) with any degree of main curve, and will not require some one or two or three particular offsets and lengths only to be used with a given main curve. Mr. A. M. Wellington, of this journal, has devised such a system, and used it very extensively in his own practice, but he has so far not been able to find time to present it as he desires to in the columns of th's journal, and consequently has not presented it at all.—Ed.)

PROPORTIONING PITOT TUBES.

Sir: Various authorities state that the "Pitot tube," used for measuring the velocity of flowing water, when reduced to proper dimensions, gives the coefficient A as unity in the formula $V = A\sqrt{2gh}$.

Where can information be had as to proper dimensions to produce such result?

Yours truly, L. Y. S.

Philadelphia, Sept. 29, 1893.

(For explanation of the theory of Pitot's tube see Church's "Mechanics of Engineering," page 803. To make a Pitot tube with the coefficient 1 in the equation $V = A\sqrt{2gh}$ it will probably be necessary to make the horizontal portion smallest at the mouth, as was done by Darcy.—Ed.)

NEW FORMS OF PLANIMETERS.

Sir: In your issue of Sept. 14, 1893, you give, over the signature Eric Swensson, what you call a novel planimeter. I have an Ashcroft planimeter which is a good help in working up cards, and which is very easy to understand, but the cut and explanation of the process of getting the area by the novel form described is not very clear to me. How do you move the hook described by hand, and how does the B point move? It seems as though the movements of the B end of the hook ought to have a little clearer explanation; and if you will make an explanation to clear up the mystery of this very novel little genius, I shall be very thankful. Yours truly, D. H. Chase.

Newark, N. J., Sept. 25, 1893.

(We are unable to satisfy the curiosity of our correspondent any more fully than we have done in the aforesaid communication. It was not entirely clear to us. We hope later to give a fuller explanation.—Ed.)

WATER SUPPLY AND DISEASE.

Sir: An interesting case, showing the relation of water supply to disease, was presented to me recently. The village of Jessenits, some 40 miles from Hamburg, was, until lately, of an unsavory sanitary reputation, typhoid fever and diphtheria having been plentiful and frequent. About 30 ft. below the village site is a stratum of clay, above which lies the water bearing layer into which common open wells of the inhabitants were sunk. Suspicion having been cast upon the water supply, new wells were driven near the old sites to a depth of 70 ft., passing through the deposit of clay. The old wells were closed and the good sanitary results were both immediate and marked. None of the former trouble has been experienced.

W. P. Mason.

Stuttgart, Wurtemberg, Sept. 20, 1893.

NOTES AND QUERIES.

F. von E. says he wishes to make some tests with concrete and iron beams. To any works provided with suitable testing appliances and sufficient space he is willing to pay a reasonable compensation. We would refer our correspondent to the testing departments of Columbia College, in this city, and of the Stevens Institute, Hoboken, N. J.

L. G. B., Charleston, S. C., asks information regarding the use for roadways of the product, or cinder after combustion, of sulphuret of iron, or iron pyrites. He says some of this material has been tried for cheapness, but he objects to it because of its lack of cohesion and the rapid manner in which it disintegrates under falling water. This water runs off highly discolored by the oxide of iron. Mixing with a fatty marl or clay might enable it to stand a light traffic. Mr. B. says he has heard of its use in England for roadways; but whether combined with other material or not is not stated. We do not know of any data upon the use of this material; but would be inclined to agree with our correspondent that it had little value under any combination.

THE CANADIAN PACIFIC RY. PORTLAND CEMENT WORKS IN VANCOUVER, B. C.

(With inset.)

The first Portland cement works erected in British Columbia, and now in operation, were built and designed by the firm of I. S. Rigby & Co., Chemical Engineers, of Wavertree, England, and Montreal, for the Canadian Pacific Ry. Co. The works are situated on False Creek, Vancouver, with a line of rails running on each side, and are arranged to produce 100 tons of cement per week, by the dry process.

Before describing these works it would be, perhaps, as well for the benefit of those who may not be acquainted with the manufacture of Portland cement, to give some particulars of the process. Portland cement is manufactured from carbonate of lime and clay, whether it be from the universal limestone, the chalk deposits which exist in England and on the continent of Europe in various places, or from the oystershell banks of South Carolina. It is all equally Portland cement, as it forms a material after it has passed through the process of manufacture that resembles in appearance the stone found at Portland, England; hence the name.

Whatever form of material may be used in its manufacture, it is absolutely necessary that it should be in as finely divided a state as possible in order to get a thorough amalgamation of the particles or atoms of carbonate of lime and silicate of alumina or clay, as a perfect decomposition in the subsequent operation of calcining depends upon it. A coarsely ground material is sure to produce an imperfect cement. In the wet process, where chalk or marl is used for making cement, no grinding is necessary. It is mixed with clay in a circular tank by means of revolving harrows and the resulting material is pumped on to the drying beds connected with suitable kilns, and is dried by the waste heat proceeding therefrom. In harder material, such as limestone, this is a source of considerable difficulty, and is only overcome by the aid of powerful machinery, unless it is burnt and the resultant lime worked by the wet process. In either case the proportions which give the best results are about 75% of carbonate of lime and 25% of clay. This is a point that requires very careful attention, and each charge should be regularly tested in the laboratory, an operation that only takes a short time to effect.

The dry process as carried out in these works may be described as follows: The raw materials at present used are limestone and clay, of which there are enormous deposits in the neighborhood of Vancouver. It is essential that the raw materials be perfectly dry, in order that they may pass through the mills.

The limestone, as received from the barges, is passed through a Blake crusher, from thence it is elevated by means of buckets to a mill. These mills, of which there are three, are capable of grinding three tons of limestone per hour to a fineness that will admit of its all passing through a 50-mesh sieve. Two of the mills are heavy edge runners, each weighing about 20 tons, and the paths and outer rims are so arranged that they can be renewed as soon as they become worn down. The limestone, after it has passed through the crusher, is elevated and delivered to the first mill where it is reduced until it passes through the perforated gratings adjoining the grinding path, and is again elevated to a separator. This separates all the fine material from the coarse; the former is conveyed to an elevator that delivers it to the stock hopper, capable of holding about 100 tons, while the coarse or "tailings" is conveyed to the

next mill to undergo a similar treatment. Any tailings from the second mill go to a small stock hopper and are again ground by a smaller mill.

The dried clay is ground in a separate mill and is conveyed to another hopper adjoining the first named. Placed beneath the hoppers are two weighing boxes fitted with conveyors, 1,500 lbs. of ground limestone being weighed in one box, and 500 lbs. of clay in the other. To facilitate the mixing as much as possible, the conveyor in the limestone box is caused to work three times as quickly as the one containing the clay. Both conveyors are set in motion at the same time and mix the material on its passage to a dry mixer, which is placed a few feet below the weighing boxes. This dry mixer consists of a cylindrical machine, 16 ft. long and 3 ft. diameter, fitted with continuous conveyors working in opposite directions. It has two annular rings which rest on four small wheels and is caused to revolve by means of gearing.

At this point a sample of the mixture is taken to be tested in the laboratory to ascertain if it is composed of the proper proportions. When found to be correct it is allowed to descend to the next floor to a "wet mixer," a semi-circular machine 8 ft. long and 2 ft. 4 ins. in diameter, made of strong cast iron, in which run two heavy shafts, having arms working at different speeds. About 5% of water is added and the mixture is thoroughly pugged and forced to the end of the trough, from whence it again descends into a brick press. Here it is made into brick-shaped blocks, which are placed on an endless band and conveyed to the drying floor or store. This floor, which is 40 × 24 ft., is heated by means of the waste heat from the boilers passing through numerous flues, covered by cast iron plates, on its way to the chimney. It will be seen that the material passes down from the top of the building by its own gravity.

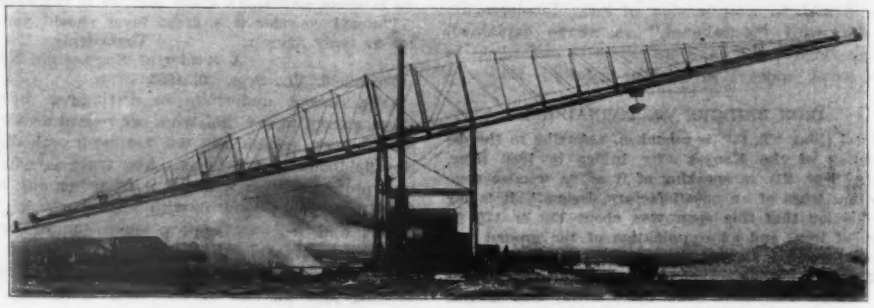
After the bricks are sufficiently dried they are placed on an elevator and carried to the top floor to the kilns, of which there are two. These are continuous kilns, and burn coal slack instead of coke, which is generally used. The kilns will produce one ton of cement at an expense of, say, 300 lbs. of fuel, whereas about 700 lbs. of coke is usually required in making cement by the wet process. The kilns consist of two compartments, built one over the other. The first is where the bricks are placed, and which is kept full, and receives all the heat which is given off from the decomposing compartment below, so that by the time they arrive at the point where the fuel is added they approach a white heat. They are gradually worked into the next compartment, where the fuel is added. This part requires very careful attention in order that the material may be thoroughly decomposed; at the same time excessive heat must be avoided or it will "flux" or form a glass and give considerable trouble by not only adhering to the sides of the kilns, but producing a very inferior cement. This style of kiln is also suitable for lime burning.

When the burning is properly conducted the material with which the kiln is charged gradually descends to the bottom and produces a heavy clinker, which upon being broken, presents a greenish-bronze appearance. It is then taken to the mills and ground, from whence it is conveyed to the floors of the house, where any excess of lime is allowed to hydrate. The time this takes varies according to the excess of undecomposed lime in the cement. This finished product is Portland cement and is ready to pack in barrels or bags.

It may be added that the whole plant is operated by a modern engine of 130 HP., with two boilers.

THE BROWN CANTILEVER HOISTS ON THE CHICAGO DRAINAGE CANAL.

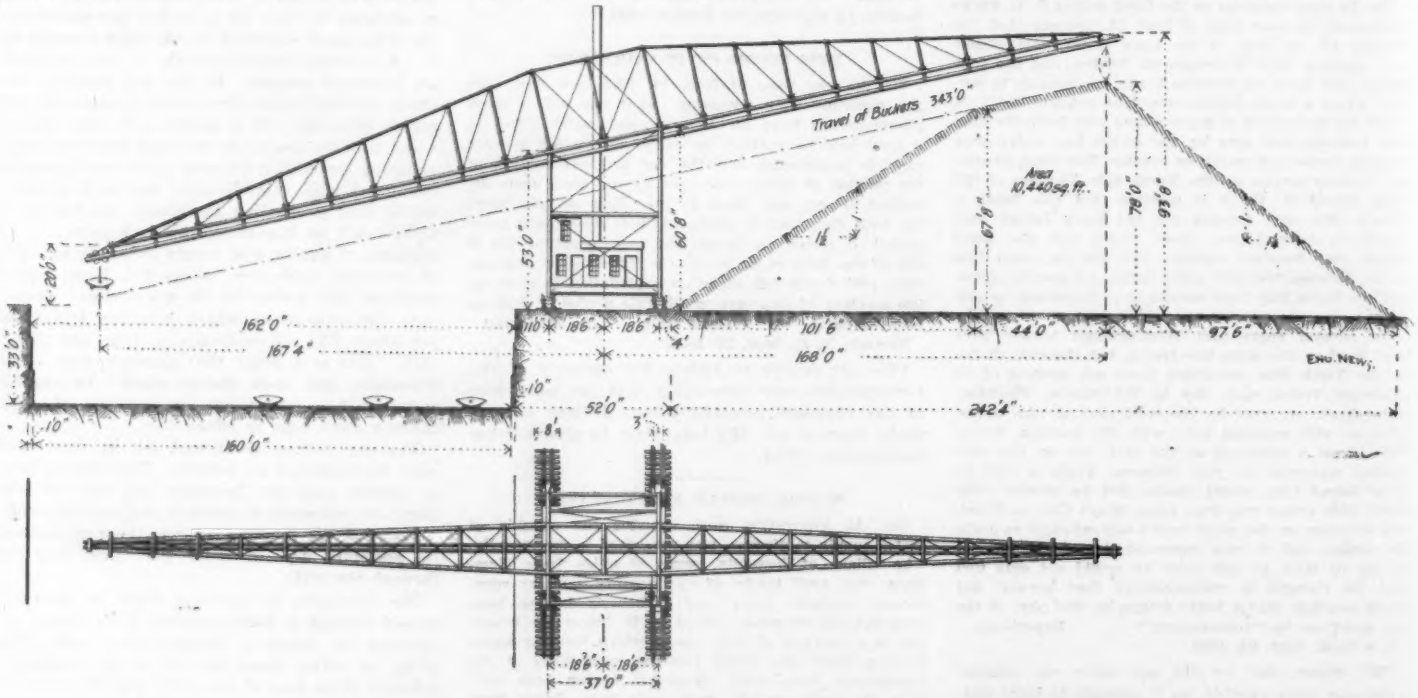
We illustrate herewith one of the big cantilever hoisting machines built by the Brown Hoisting & Conveying Machine Co., of Cleveland, O., for work on the Chicago Drainage Canal. The cut on this canal for several miles is through solid limestone overlaid by only a foot or two of earth. The contractors are required to take out this material and dump it on the bank on one side. The side elevation of the machine shows the cross-section of the canal and also by a dotted line the possible height of the spoil bank at each point under the shore arm of the cantilever.



PERSPECTIVE VIEW OF BROWN HOIST.

As seen by our drawings, the machine consists of a light truss, 355 ft. long over all, composed of two connected cantilever arms supported on a light tower, bringing the center of the truss 56 ft. 10 ins. above the base of the tower. The truss is inclined at an angle of 12° 50′, so that one of the arms projects downward over the canal and the other projects upward over the dump. The tower is composed of four columns, each of which rests on a four-wheel car truck. These trucks run on a double line of tracks, spaced 37 ft. between centers, laid parallel to the line of the canal. By connection with the hoisting engines in the base of the tower, the entire structure can be moved along the tracks to bring the hoist directly over the bucket to be raised. The usual speed at which the structure is thus moved is 150 to 200 ft. per minute, or about the usual speed of modern overhead traveling cranes, but this speed can be increased to 400 ft. per minute if desired.

The hoisting machinery on the truss consists of a four-wheel trolley running on tracks laid along the lower chord and having a fall block suspended from it. In the base of the tower and serving as ballast is the hoisting machinery, consisting of an engine specially designed by the Brown Hoisting & Conveying Machine Co., with two 10½ × 12-in. cylinders and a band friction clutch mechanism. All the movements of the machinery are controlled by three levers, one of which makes the connections to hoist the bucket, one moves the trolley, and the third moves the whole machine along the tracks. The total length of travel of the trolley is 343 ft. The dumping of the bucket is effected at any desired point on the upper cantilever arm by an automatic mechanism.



CANTILEVER HOISTING AND CONVEYING APPARATUS IN USE ON THE CHICAGO DRAINAGE CANAL.
Designed and Built by the Brown Hoisting & Conveying Machine Co., Cleveland, O.

The buckets used for hoisting the broken rock are mounted on small wheels to facilitate moving them about when empty. The capacity of the bucket is 75 cu. ft. even full, or about 7,000 lbs. of broken limestone. In work on the canal large pieces of solid rock are often put in the bucket and it is heaped more or less, making the load as much as 9,000 to 10,000 lbs. The builders guarantee the capacity of the machine to equal 25 trips per hour, or 88 tons of rock handled. A trip means hoisting the loaded bucket, running the trolley to the upper end of the cantilever, dumping the load and returning the empty bucket to the canal bed. The best recorded average for an entire day's work was 32 trips per hour, and the limit was not the capacity of the machine, but the ability of the workmen in the pit to load the buckets for it. By waiting until a number of loaded buckets were ready the machine has made 9 trips in 13 minutes, or at the rate of 41½ trips per hour. Its builders claim it to be capable of a round trip in 45 seconds.

In a short time there will be 11 of these machines in operation along the line of the canal. Some of them have been purchased outright by the contractors, but on others the builders of the machine have made contracts by which they supply and operate the machines, paying all the expenses in connection therewith, and receive as compensation a price per cubic yard which it is pretty safe to say is less than was ever before paid for hoisting and conveying broken rock a similar distance.

In the drawings and photograph the machine appears top-heavy and unstable; but it must be remembered that the weight of engines, boilers, fuel and water supplies in the base of the tower serves as ballast, and is probably sufficient to preserve the structure from an upset in anything short of a tornado. It is true that in the 72-mile gale of April 7 last one of these machines was wrecked, as recorded in our issue of April 13; but the accident was not due to the top-heaviness of the structure, but to insufficient brake power on the trucks, only one of the four trucks being equipped with brakes. The wind pressure came against the side of the truss and was so heavy that it pushed the machine at considerable speed to the end of the track, notwithstanding the brakes, and, of course, the structure toppled over when the leading trucks went off the tracks at the end.

We have described the work on the canal in our issues of June 1 and Aug. 17, 1893. A question which has received no small consideration is to what use these expensive hoisting machines can be put after the work on the canal is completed. Probably some of them will be left in place on the banks of the canal, for use in taking the broken rock from the spoil bank and dumping it on barges in the canal. This will furnish a well nigh inexhaustible supply of broken stone, suitable for macadamizing, making concrete or other purposes; and with the advantage of cheap handling and water transportation, will doubtless prove a great boon to Chicago and its suburbs and to the sections of Illinois which can be reached by water transportation from the canal.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 247).

Progress on the Filter Beds at Brockton, Mass.

During a hurried visit to Brockton on Sept. 30 the following information was secured regarding the progress and character of the intermittent filtration area now being prepared to receive the sewage of the city:

The beds are well along toward completion, but will not be put in use for about a year, owing to the fact that the sewerage system within the city is not yet built, although Brockton has a population of about 30,000. The force main, about three miles of 24-in. cast iron pipe, has been laid, and the foundations for the pumping station have been started, but the contracts for the pumps have not been let.

The filtration area will include about 30 acres, originally covered with pine woods and bushes. Before construction was decided on, 80 test wells were sunk at different points and about 400 samples of the material encountered were taken. These samples have been preserved in 4-oz. glass bottles, each labeled as follows: Number of test well; number of sample; depth sample was taken; color and quality, whether fine or coarse sand, gravel, loam, or other material.

A good bed of coarse gravel, with some exceptions, was found underlying a layer of top soil and loam. This gravel is being stripped and the top soil and loam is placed in the embankments, which latter are unusually high, owing to the large amount of material to be removed. The slopes and tops of the embankments are being carefully graded, and seeded.

Underdrains 5 ins. in diameter are being placed 50 ft. apart and at the unusual depth of 7 ft. These connect with 8-in. and the latter with 15-in. main drains. By means of weirs in manholes, the effluent of each bed may be measured and also that from the three main drains; the latter have self-recording indicators which will be connected with the city engineer's office. All the sewage pumped will go to one bed until a change to another is made. By these provisions the amount of sewage applied to each bed, the effluent from each bed and the total effluent may be known. It is expected that a large number of analyses of the effluent obtained will be made by the State Board of Health in order to test most thoroughly the results obtained from different materials, some variations in the beds having been made with this end in view. In putting down the underdrains, notes are being taken regarding the material encountered, for future use. Some strata of fine material have been found. In trenching for the underdrains a considerable saving of labor has been effected by making alternate open trenches and short tunnels, the material admitting of this.

The effluent will pass from the three main drains to a brook emptying into the Coweesett River, which in turn empties into the Taunton River, more than 20 miles above the intake of any water-works. The volume of the river is at times comparatively small, so purification was necessary.

A set of meteorological instruments is to be bought by the city, including three rain gages, one to be placed at the filter beds, one at the water-works and one at the city hall. At present everything indicates that the Brockton works will be the most scientifically designed and constructed intermittent filtration plant in this country, if not in the world. Mr. F. H. Snow is City Engineer, and has designed and is constructing the plant. We are indebted to Mr. Snow and to his assistants, Messrs. F. A. Barbour and H. H. Goss, for the information given.

Notes at Gardner, Mass.

On Sept. 30 the filter beds at Gardner, Mass. (see Eng. News, Feb. 16, 1893), were found in excellent condition, so far as could be determined by cursory inspection. During the past summer the settling tanks were cleaned about twice a week, but at present one cleaning a week is sufficient. On Sept. 23, or one week before the writer's visit, the tanks had been cleaned and the sludge on the sludge bed was just ready for removal, having been rolled up in strips, by means of a rake. These rolls are thrown into a wheelbarrow and removed to a heap close by. No dirt had been thrown over the sludge heap, at least not for some weeks, but it was comparatively inoffensive close at hand and entirely so a very few feet away.

The filter beds are still operated with two-day intervals of rest, the small amount of matter that collects on their surface being raked off and the surface of the beds stirred with the rake. In cleaning the bed the attendant passes over it as freely as he chooses, without regard to packing it down, but, of course, the raking keeps the surface loose. Only one attendant, an intelligent laborer, is employed at the beds.

The attendant stated that during the severe weather of last winter, for a good part or all of the time, sewage was applied to but three of the beds near the settling tanks, the overflow from these passing to two beds some distance away and overflowed into the woods.

THE DUTY OF WATER FOR IRRIGATION IN COLORADO.

In Colorado, as in other parts of the arid West, the land needing irrigation is in excess of the water supply available for this purpose. It is, therefore, important to know how much land, under a certain crop, can be irrigated with a given quantity of water, or, in other words, the duty of water for a given crop. It is obvious that this duty will vary according to the care with which the water is applied to the crops, the evaporation and seepage which takes place in the passage of the water from its source to the crops, the character of the irrigated soil, depth to ground water and the amount of rainfall in the locality under consideration, and other factors. The waste of water by evaporation and seepage will depend upon the carriers which bring the water to the irrigated area, whether open or closed and if open whether their sides and bottom are cemented or otherwise treated to prevent leakage. The evaporation will also vary with climatic conditions. Some crops, of course, require more water than others, and some methods of application are more wasteful than others. Thus, it is evident that altogether the duty of water depends upon natural and artificial conditions, the latter involving good engineering in the construction of the irrigation works, and good management after their completion.

Table 1.—Water Applied to Alfalfa, Clover, Wheat and Oats on Farm of J. H. McClelland Near Fort Collins, Colo., in 1892.

Date.	Hours applied.	Acre-ft.	Depth, ft.	Remarks.
Forage Crops.				
Alfalfa—13.5 acres.				
May 19....	10	3.71	.47	First irrigation.
" 28....	12	2.60		
July 6.....	10	4.78	.36	
	32	.....	.83	
Rain.....	..	.....	.84	From April 1.
Total.....	..	.....	1.67	
Alfalfa—36 acres.				
May 27-28.	12	2.74	.51	
" 29-31.	58½	15.45		
July 11-17.	120	18.11	.50	
	188½	.....	1.01	
Rain.....	....	.....	.84	From April 1.
Total.....	....	.....	1.85	
Clover—14.3 acres.				
May 28-29	12	2.93	.54	First irrigation; in night, perhaps one half waste.
May 31, J. 1	16	4 82		
July 1-2..	14	4.38	.60	Second irrigation.
" 3-4..	13	4.14		
" 9-10.	17	4 34	.30	
	72	....	1.44	
Rain.....	..	....	.84	
Total.....	..	....	2.28	
Cereals.				
Wheat—34 acres.				
June 1-4..	72	19.10	.96	First irrigation.
" 6-8..	33	7.15		
" 10-11.	23	5.53		
" 13 ..	3	.73	....	Cut about Aug.16
July 6-9..	49	13.96	.41	
	180	.....	1.37	
Rain.. ...	....	.....	.83	
Total.....	...	.....	2.20	
Wheat—38.5 acres.				
June 6-8 .	72	21.24	.55	First irrigation.
July 10-11.	28	13.05	.34	2nd, incomplete.
	100	.....	.90	
Rain.....	....	.....	.83	April 1 to Sept. 1.
Total.....	....	.....	1.72	
Oats—17.4 acres.				
June 11-14	66	17.83	1.02	
July 2-3...	36	9 75	.56	
" 17....	12	2.10	.12	Incomplete watering.
	114	....	1.70	
Rain.....	....	....	.83	
Total.....	....	....	2.53	

In Europe and the East much attention has been paid to the duty of water, but in this country only a little accurate information is available, most of the results secured by those who have given the matter attention never having been made public.

The Experiment Station of the Colorado State Agricultural College, of Fort Collins, Colo., is investigating irrigation problems under the direction of Prof. L. G. Carpenter. The results of three years' observations on the duty of water have been published as Bulletin No. 22, of the station, by Professor Carpenter, from which the following abstract has been made:

The ordinary way of expressing the duty of

water is to state the number of acres irrigated by the constant flow of a given quantity of water, as 1 cu. ft. per second. For estimating the number of acres which may be irrigated from a reservoir, or for stating the amount of water used during a season, a unit known as an acre-foot, or the amount of water required to cover one acre of land 1 ft. deep, or 43,560 cu. ft., is more convenient. The amount of water used in 1892 on 154 acres of land in different crops owned by J. H. McClelland, three miles from the college, is given in Table I. There were two different plots of alfalfa, two of wheat, one of clover and one of oats.

Professor Carpenter states that the duties for a constant flow of 1 sec.-ft., based on the above table, would vary from 12 to 400 acres, according to the assumed length of the season and whether or not the rainfall was considered.

Results of observations on other farms are given in the bulletin, which can doubtless be obtained by addressing the Experiment Station, Fort Collins, Colo.

It being desirable to ascertain the amount of water used by a whole community under one ditch arrangements to this end were made on Cache-a-la-Poudre Canal No. 2, one of the first built by the Union Colony of Greely, having been laid out in 1870 by Mr. E. S. Nettleton. The canal has since been enlarged and now has an official rating of 585 cu. ft. per second. The area watered is about 24,000 acres. The canal is 35 miles long, has a grade of 2.56 ft. per mile and passes most of its length through sandy loam. The loss from seepage is not definitely known. The approximate acreage of various crops under the canal is 7,500 acres of alfalfa, 800 of native grasses and 18,500 of cereals and potatoes, but of this some 3,000 acres is irrigated from seepage and from reservoirs.

The amounts of water taken into the canal in each month of the season in 1890, 1891 and 1892, in acre-feet, and the corresponding duty in acres per second-foot, are given in Table 2.

Table 2.—Amount of Water Taken Into Cache-a-la Poudre Canal No. 2 for Each Month of the Seasons 1890, 1891 and 1892, and Duty for Various Periods in Each Year.

Intake in Acre Feet.

Month.	1890.	1891.	1892.
April	*	*	741
May	3,582	7,746	7,759
June	20,850	15,090	22,216
July	12,426	16,932	17,266
August	6,372	2,848	2,089
September	1,324	1,334	175
October	*	296	*
Total	44,554	38 206	50,250
Corresponding depths o er 24,000 acres, in feet	1.86	1.59	2.09

* Intake small, principally for stock or trees.

Duty, Acres per Second-Foot.

Period.	No. of days.	Canal alone. 1890.	1891.	1892.	Canal and rain. 1890.	1891.	1892.
May 1—Sept. 1..	123	132	153	112	105	108	81
April 1—Sept. 1.	153	164	192	146	131	134	101
May 1—Nov. 1...	184	198	232	176	153	155	124
June alone.....	30	72	95	65	71.5	56.5	55.5

Figures for the whole Poudre Valley and for the Larimer & Weld canal are also presented in the bulletin. The summary of these figures is given in Table 3.

Table 3.—Duty of Water from Two Canals Drawing Water from the Cache-a-la-Poudre River, and from the Whole Poudre Valley, With and Without Seepage.

Depths in Feet.

	May 1 to Sept. 1, 123 days.		April 1 to Sept. 1, 153 days.		April 1 to Nov. 1, 184 days.		June, 30 days.	
	D'pth from irrigation.	Irrigation and rain.	D'pth from irrigation.	Irrigation and rain.	D'pth from irrigation.	Irrigation and rain.	D'pth from irrigation.	Irrigation and rain.
No. 2 Canal	2.09	2.86	(2 09)	3.03	(2.09)	2.96	.925	1.12
Larimer & Weld Canal	1.49	2.26	1.49	2.43	1.49	2.36	.73	.93
Valley.....	1.25	2 02	1.30	2.24	1.33	2.22	.64	.84
Valley, seepage included	1.41	2.18	1.50	2.44	1.57	2.46	.68	.88

Corresponding Duty per Second-foot, in Acres.

No. 2 Canal..	112	81	146	101	176	124	65	53⅓
Larimer & Weld Canal	105	159	205	136	216	155	81	64
Valley,..	195	122	233	136	274	168	94	71⅛
Valley, seepage included.....	174	113	201	125	244	151	88	68

Some of Professor Carpenter's remarks on the ultimate duty of water may be quoted as follows:

A large amount of water is needed for carrying on the vegetable processes, and this must fix the ultimate duty to be expected from water even under the most economical methods. Ordinarily it may be estimated that for each pound of dry matter produced, 300 times as much water has been evaporated from the leaves. Some variation is to be expected in different kinds of plants, and in the same kind under different conditions; but, as a whole, the variation is less than might be supposed. The subject has been experimented upon by many. According to the experiments of Hellreigel, quoted by Storer (Agriculture, 1:14), the cereals require more than the leguminous crops, weight for weight; and of the cereals, oats more than wheat, the amount varying from 376 lbs. for oats to 273 for peas, for each pound of dry matter produced. If the ratio be considered as 300 to 1 for alfalfa, then to produce three cuttings of 3,000 to 4,000 lbs. each per acre during the season a depth of from 12 to 16 ins. must have been available for transpiration from the leaves for the growth of the crop. There is, in addition, some growth of the roots in the soil which would require an additional amount of water. If this growth be considered as confined to five months, say 153 days, as used in some of the preceding tables, the net duty of 1 cu. ft. per sec. could not exceed 225 acres, even if there were no waste. Such water as the plant secures from other sources than irrigation, as rainfall, from ground water, etc., would lessen proportionately the amount which it would be necessary to supply by irrigation, but when it is considered that this does not allow for any of the losses by evaporation or seepage from the ditches, evaporation from the surface of the soil, or losses by downward filtration, which in the aggregate are large, we may consider such a duty as exhibiting good, if not the best practice.

The bulletin concludes with a diagram for determining the duty of 1 sec.-ft. of water, which is reproduced herewith. Professor Carpenter's explanation of his diagram is as follows:

Knowing the depths which may be necessary during the season and the number of days in which it must be applied, the diagram shows the number of acres which 1 cu. ft. per sec. flowing constantly during that time will serve, or the duty. Thus, if 1 ft. is needed for wheat in 40 days, look at the right for the depth required. At the top find the vertical line corresponding to the number of days as 40 in which the amount of water is needed, say, 1 ft. for wheat. At the intersection of the two lines is the diagonal line showing 80 acres as the corresponding duty.

IRRIGATION WORKS ON THE CROW INDIAN RESERVATION, MONTANA.

The development of irrigation works largely by the labor of Indians and wholly under government direction, with Mr. Walter H. Graves as superintendent and engineer, has been going on for two or three years within the limits of the Crow Reservation, in southern Montana. This work is in accord with the common-sense belief of many that the true way to deal with the Indian is to set him to work and to make him self-supporting; a belief which need not be discussed here.

The area of the Crow Reservation is nearly as great as that of the State of Connecticut, which has an area of 4,750 sq. miles. It has a general altitude of 3,500 ft. above sea level, ranging from 2,700 to 8,500 ft. The climate is said to be suited to any of the ordinary crops or fruits raised in the Western states.

The most important river, so far as irrigation is concerned, is said to be the Big Horn, which flows into the Yellowstone, near the northeast corner of the reservation, has a drainage area of 22,000 sq. miles, and by gaging on the reservation has been shown to have a flow of 2,200 to 5,700 cu. ft. per second. The Little Big Horn is an important tributary of the Big Horn River. A large amount of land suitable for irrigation and within reach of canals is situated on these two streams, while on the south side of the Yellowstone River there are from 40,000 to 50,000 acres of bottom lands within the reservation which could probably be served by one irrigation system.

In 1890 the Indians sold 1,800,000 acres, or some 2,800 sq. miles, to the government for $946,000, of which $200,000 was set apart for the construction

Fig. 2. Obstruction on a Ditch Line; Indian Grave.

of irrigation works, not more than $50,000 to be expended in any one year, and $75,000 for the maintenance and management of the system. The act ceding the land to the government provided that in employing labor for the construction of the works, preference should be given to such Crow Indians "as are competent and willing to work at the average wages paid to common laborers for the same kind of work," and also that "the labor so employed shall be paid in cash."

In May, 1891, Mr. Walter H. Graves, an irrigation engineer, was commissioned to serve as superintendent of irrigation for the works to be constructed under the above act. From July 14 to Dec. 12, 1891, Mr. Graves was engaged in making surveys and studies, and in 1892 a ditch ten miles long was constructed, and two others started, under his direction, the total expenditure having been about $25,000.

Mr. Graves has kindly sent us a number of photographs showing the Indians at work on these ditches, and as an Indian at work may be thought by many a strange thing, we reproduce one of the views, Fig. 1, which shows some Indians working with scrapers. An obstruction on a line of one of the ditches, in the form of a so-called Indian grave, in a tree, is shown by Fig. 2. Considering the fact that the Indians were entirely unaccustomed to such work, and in fact practically strangers to work of any kind, it is said that they did very well on the ditch construction.

FIG. 1. INDIANS CONSTRUCTING AN IRRIGATING DITCH ON THE CROW RESERVATION, MONTANA.

The ditch constructed in 1892 heads in the Little Big Horn River, where a low dam was constructed across the stream, the river at this point being 230 ft. wide. The dirt was loosened by plows and removed from the ditch by scrapers. At five miles from its head the ditch has a bottom width of 12 ft., depth of 7½ ft., inner slope of 2 to 1 and top width of bank of 6 ft.

Altogether this work is very interesting and it remains to be seen what the Indians will do with the water when it is availiable for use. Irrigation ditches have been constructed on Indian reservations before this, but it appears that either their construction or management has been faulty.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Deviating from Petition to Lay Out Highway.

Where a petition for a highway calls for a change of course at a certain point, the fact that the highway is run eight rods beyond such point before changing the course will not vitiate the proceedings, as the commissioners are not bound to follow with precision the route specified in the petition. Cecil v. Carman, Supr. Ct. N. Y., 23 N. Y. Supp., 380.

Boundaries of City Streets.

In ascertaining the true line of a city street, fences built by adjoining lot owners on the line of the street, according to stakes set by the surveyor soon after the original survey was made, and maintained for 45 years, are better evidence of the location of such line than a new survey made 40 years after such survey, which changes the line. City of Racine v. Emerson, Supr. Ct. Wis., 55 N. W. Rep., 177.

Liability of City for Defective Bridges.

A city is liable for injuries resulting from the falling of a bridge built by millowners in a public highway, and by the side of a public bridge, where the public are allowed to use both indiscriminately, without notice as to the private character of the one in question. Detwiler v. City of Lansing. Supr. Ct. Mich., 55 N. W. Rep., 361.

Adoption by Council of Expenditures by Committee.

Where city councils adopt and ratify the acts of a committee therof in making necessary expenditures, which, however, the committee had not authority to make, the city will be bound thereby. The requirement that proposals to furnish a city with materials needed shall be advertised for need not be complied with where the thing needed is part of a patented article, which can be bought only at one place. The provision of an ordinance that the fire committee of a city council shall have power to contract for necessary repairs, not to exceed a certain amount, does not prevent the council from adopting the act of the committee in making a larger expenditure. Silsby Mfg. Co. v. City of Allentown. Supr. Ct. Pa., 26 At. Rep., 646.

Negligence of Sub-Contractors.

Where a person obtains from a city, by ordinance, license to lay pipes along its streets, he will be liable for injuries resulting from the negligent manner in which such work is done, even though the work is not done by himself, but by an independent contractor employed by him for that purpose. Colegrove v. Smith. Supr. Ct. of Cal., 33 Pac. Rep., 115.

Validity of Assessment for Street Improvements.

Under a charter conferring on a city power to pave its streets, and to require owners of adjacent lots to pave one-half in width of the street contiguous to their respective lots, the owners of lots on each side of the street are required to pay for one-half of the paving, whether the paving covers a part only or the full width of the street, and whether the paving is in the center of the street or on one side only; and, where the paving is on one side only, the adjacent owner on that side is only liable for one-half the expense. Under a city charter authorizing it to require the abutting lot-owners to pave a street, a railroad company having a right to lay its track on a lot, but to which it did not have title, is not liable for paving the street. City of Muscatine v. Chicago, R. I. & P. R. R. Co., Sup. Crt. of Iowa, 55 N. W. Rep., 100.

Remedy at Law for Trespass.

Where a contractor has made a valid contract with a city to pave and curb a street, and is liable for penalties for its non-performance, he is entitled to an injunction against trespassers who prevent him from doing the work, as he has no adequate remedy at law, and an injunction will avoid a multiplicity of suits. Palmer v. Israel, Supr. Ct. of Montana, 33 Pac. Rep., 134.

Payment of Damages by City, and Recovery from Property Owner.

Where a cellarway, trap door or scuttle or the like is put in a public sidewalk for the convenience of the abutting property, as between the owner and the city the duty of maintaining it in a safe condition devolves upon the former, and he cannot release himself of his duty by merely abandoning the use of the structure. He can only do so by removing it and restoring the sidewalk to its original condition. If, through the negligence of the property owner, the structure becomes unsafe and injury results, for which the city is liable because of neglect of its duty to keep its streets in a safe condition for travel, it may, upon payment of the damages to the person injured, recover from the owner by whose fault, "as between him and it," the injury was occasioned. City of Wabasha v. Southworth, Supr. Ct. Minn., 55 N. W. Rep., 818.

Action for Injuries Caused by Defective Street.

Where the statute provides that whenever any person is injured by reason of any defect in any street, or for any other cause for which the city would be liable, and such injury shall be caused by the negligence of any person or corporation or towns, such person or corporation or towns shall be primarily liable for all damage arising from such injury, but such city may be sued in the same action with the one so primarily liable. Such statute is not limited in its application to cases in which the person guilty of such wrong, default or negligence sustains no contract relation to such city, but applies as well where such person was grading a street under a contract with the city. (Kollock v. City of Madison. Supr. Ct. of Wis., 54 N. W. Rep., 725.)

Liability of City for Defective Sidewalk.

Where an action against a city for injuries sustained by a defect in the sidewalk, the evidence showing that the flagging in the sidewalk had a hole in it from five to six inches in diameter, in which one caught her foot and fell, it appearing that the hole was in the flagging when it was laid, five or six years before the accident, and it had originally been filled with dirt, but it had been partially swept out, so that at the time of the accident it was about an inch deep at the edges, and deeper in the middle, the surface being saucer-shaped, a jury was warranted in finding that the hole was a defect for which the city was responsible, under the statute providing that, if a person suffers injury through a defect in a highway which might have been remedied with reasonable care, he may recover. (Marvin v. City of New Bedford. Supr. Ct. of Mass., 33 N. E. Rep., 605.)

Rights of Lowest Bidder.

Where, by statute, public officers are required to advertise for bids for the performance of certain public work, and to give the contract to the lowest bidder, the person whose bid is lowest is entitled to the contract, and can enforce his rights by mandamus, or by action against the officers for specific performance, or perhaps for damages. This is upon the principle that a tender and acceptance constitute an agreement, and it was held that where bids were called for for the performance of certain work according to certain specifications, the work to be given to the lowest bidder, that the lowest bidder for the work, even though his bid was informal, amounted to a tender on his part and an acceptance on the part of the owner which made a complete and binding contract, and its provisions were enforced against him.

And though nothing is said in the call for bids as to whether the work shall be given to the lowest bidder, yet, if such is the custom and common understanding, the lowest bidder has a right to treat his bid as accepted, unless it is expressly rejected. But if by the terms of the call for bids a written contract is to be entered into and signed by the parties, after acceptance, the contract is not complete until this is done, and it seems that either party may withdraw before this is done. In fact, if anything is left open to be done before the agreement is complete, either party may recede. In order to make the bid and acceptance a complete contract, nothing must be left to be done by the parties. When a call for a bid for work refers to a certain plan and specification, the plans and specifications are treated as incorporated into, and forming a part of the contract as well as all other matters referred to in the call. And where compensation is to be made out of a particular fund no claim can be made except against that fund.

When, however, the law does not require the work to be given to the lowest bidder, and the call for bids does not state that the work will be so given, or when any discretion is vested in the contracting board, the lowest bidder cannot enforce his claim. The same is true in the case of an individual advertising for bids for the doing of certain work, unless he expressly states in the call that the work shall be given to the lowest bidder, or there is some custom regulating the matter, he is at liberty to accept any bid which he deems most advantageous, whether it is the lowest or not. (Abstracted from Wood on "Master and Servant.")

The bonded and floating indebtedness of the Chicago World's Fair is to be paid off by Oct. 9, says the chairman of the finance committee. The sum required is $1,900,000.

The New York Dock Board projects for improved docks in New York harbor were blocked for the present by the negative vote of City Controller Meyers at the meeting of the Sinking Fund Commissioners on Sept. 30. The schemes thus laid over include the North River improvements, between Charles St. and W. 23d St.; the mile of docks opposite Riverside Park and the Harlem River improvements from 138th St. to 7th Ave. Mayor Gilroy, as one of the Commissioners, vigorously objected to the negative vote, and is said to have given notice that he would do what he could to have the law changed so that no one member of the board could hereafter prevent important action.

The Intramural Electric R. R., at the Columbian Exposition, ran on Railroad Day, Sept. 16, a train of eight cars fully loaded, weighing, all told, about 212 tons, the whole being hauled with ease by the motors on the head car, whose nominal capacity is about 200 HP., but which can develop on necessity as much as 500 HP. for a short time. On the day previous, by way of a test, one motor car hauled 11 empty cars over the road, making a longer though somewhat lighter train than the one handled on the following day.

A chance for electrical inventors is offered by the Ohio Legislature. Sealed proposals will be received up to Nov. 30 for an electrical apparatus so arranged that the desk of each member will be connected by wire with the Clerk's desk, and a vote can be taken by each member pressing a button, and the vote will be automatically recorded at the Clerk's desk. As the total expenditures of the committee having the matter in charge are limited to $1,000, the Ohio Solons evidently rate electrical machinery and inventors' abilities at a low figure.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BANGOR & AROOSTOOK.—The citizens of Patten, Me., are reported as trying to secure an extension of this railway to that place. The branch would be five miles long.

BOSTON & ALBANY.—The stockholders have voted to issue bonds not to exceed $5,000,000, of which $3,000,000 will be for construction account between Boston and Springfield.

FITCHBURG.—The stockholders have authorized the issue of $2,500,000 of bonds, of which $200,000 will probably be available for equipment, etc.

MICHIGAN.—Construction was commenced Sept. 14 by about 200 men on a logging railway which commences five miles northeast of Sidnaw, Mich., at the Sturgeon River, and is to extend 10½ miles in a southerly direction to timber lands of the Nestor estate. The maximum grade will be 2%, and maximum curvature 10°. The timber tract will cut about 60,000,000 ft. Ch. Engr., T. M. Reiter, Sidnaw, Mich.

OHIO & MISSISSIPPI.—The extension of this railway from Mitchell Hollow, Ind., to a connection with the Bedford Belt R. R. at Bedford, a distance of about three miles, has been completed and opened for traffic.

TOLEDO & OHIO CENTRAL.—Tracklaying has been completed on the extension from Ridgway, O., south to Columbus, a distance of 52 miles, and the ballasting will be finished and the line opened for traffic within a few days. It is expected to have the terminal at Columbus completed by May 1.

Projects and Surveys.

CAPE BRETON.—The preliminary line from Hawkesbury to Louisburg has been surveyed by the Cape Breton R. R. Extension Co., and surveys are now being made for a branch from Sidney to Marion Bridge.

CLEVELAND & SOUTHWESTERN.—Maj. G. M. Anderson, Detroit, and D. R. Cook, Hastings, Mich., are in charge of the preliminary work of obtaining the right of way for this projected road. As at present planned it would extend from Cleveland, O., to the Cleveland, Lorain & Wheeling R. R. between Grafton and Medina, a distance of about 30 miles, and it would give the latter road a direct entrance to Cleveland, it at present using the track of the Big Four road from Grafton. The line is expected to be in operation within two years.

NEW YORK, NEW ENGLAND & NORTHERN.—The state railroad commission has granted permission for the construction of this proposed road, referred to Sept. 21 and in previous issues. Pres., A. A. McLeod.

NORTHERN INDIANA.—Incorporated in Indiana to build a railway along the lake shore in Lake county; capital stock, $70,000.

NOVA SCOTIA.—It is reported that a proposition has been made to the town council of Dartmouth, N. S., for a branch railway from that place to Windsor Junction.

OHIO LAND & RY. CO.—Incorporated in Ohio to promote the coal traffic of the Columbus, Hocking Valley & Toledo Ry., by building branches, acquiring lands, etc. Agents have been purchasing land for the company for two years, according to reports, and have already secured 10,000 acres of coal lands with leaseholds on 10,000 additional acres; capital stock, $2,000,000; Pres., C. O. Hunter; Secy. and Treas., E. A. Cole; principal office, Columbus, O.

QUINCY QUARRY CO.—Bids are asked until Oct. 7 for grading 1.1 miles of roadbed for a railway belonging to this company. Clk., Andrew Milne; Engr., H. T. Whitman, Quincy, Mass.

Southern—Existing Roads.

CARRABELLE, TALLAHASSE & GEORGIA.—This railway was completed from Carrabelle, Fla., north to Sopchoppy, 20 miles, last year, and the work is rapidly progressing toward Tallahassee, about 30 miles from Sopchoppy. A cargo of rails was received last week, and two more vessels are reported as on the way with rails for this road. Gen. Man., A. Orr Symington, Carrabelle, Fla.

CENTRAL R. R. OF GEORGIA.—It is reported that the Savannah & Atlantic Ry. may be rebuilt. It extends from Savannah, Ga., to Tybee Island, 17.7 miles, and part of the roadbed was washed away by the recent storm. About 15 miles of the line is laid with 30 to 50-lb. steel rails.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—The extension of this road south from Eau Gallie, Fla., has been completed to Melbourne, on the Indian River, and regular train service was inaugurated Oct. 2.

NORFOLK & WESTERN.—The five-mile extension in Logan Co., W. Va., to the property of the Pearl Coal Co., has been graded for four miles, and the entire extension will soon be completed.

LOUISVILLE, NEW ORLEANS & TEXAS.—It is stated that the Natchez, Jackson & Columbus narrow gage line between Harriston, Miss., and Jackson, a distance of 70.7 miles, will be changed to standard gage. The line between Natchez & Harriston, 20 miles, is already standard gage.

Projects and Surveys.

CHILHOWEE MINING & RY. CO.—Incorporated in Tennessee to mine coal and copper and to construct a mining railway at Bradley, Bradley Co.; W. K. Spadden, E. T. Hall, E. F. Campbell, S. Reese, W. S. Tipton.

TENNESSEE & EASTERN.—Incorporated in Tennessee to build a railway from Chattanooga, Tenn., to Murphy, N. C.; J. L. Conable, Chas. G. Sherman, E. M. Conable, A. W. Gaines, W. M. Allen.

Northwest—Existing Roads.

CHIPPEWA RIVER & MENOMINEE.—The Chippewa Falls, Wis., "Independent" states that this railway has been extended six miles this summer. It was intended to extend the line to Hayward, but owing to

the hard times this has been postponed until next season. The road is now 26 miles in length and will be constructed to Hayward, a distance of 28 miles from its present terminus. The principal business at present is that of hauling logs, but there is also a good deal of freight hauled, and the passenger trade increases each year. The company intends to extend the road to this city and Lake Superior.

GREAT NORTHERN.—The stock of the Sioux City & Northern Ry. and all the bonds of the Sioux City, O'Neil & Western R. R. are reported to have been purchased by representatives of this company for $1,000,000. The report, however, is claimed by officials of the company to be false. It is stated that the proposed extension from Yankton, S. Dak., to Norfolk, Neb., will be built within 18 months. In our issue of Sept. 7 we reported the purchase of 18 miles of the roadbed of the projected Yankton & Norfolk R. R. The entire listance is 64 miles.

Southwest—Existing Roads.

CHOCTAW COAL & RY.—A petition is being prepared to be presented to congress asking for an extension of time in which to complete this road. It is said that about 112 miles have already been constructed and equipped, at a cost of $3,500,000, and an extension of two years is asked for building from South McAlester to Oklahoma City, a distance of 125 miles.

EXCELSIOR SPRINGS.—This road has been completed from Excelsior Springs, Mo., to Cooley's Lake, a distance of about 10 miles, and will be operated by the Wabash.

MISSOURI, KANSAS & TEXAS.—It is reported that an extension of this railway will be built from Waxahachie, Tex., through Navarro, Freestone and adjacent counties to Trinity, Tex., where it would connect with the Sabine River branch of the same system. The distance is about 110 miles.

ST. LOUIS & SAN FRANCISCO.—An extension of this road from Sapulpa to Guthrie, Okla., a distance of about 70 miles, is under consideration.

SUGARLAND.—This railway has been graded and tracklaying will probably be commenced this week. The line extends from Sugarland, Tex., to Arcola Junction, 14.2 miles, as stated in our issue of last week.

TEXAS MIDLAND.—It is reported that work on the proposed extensions of this road will be commenced this week. The extensions are from Roberts to Paris and from Garrett to some southern point. Pres. and Gen. Man., E. H. R. Green, Terrell, Tex.

Projects and Surveys.

GAINESVILLE, McALESTER & ST. LOUIS.—Surveys for this proposed railway have been completed between Gainesville, Tex., and McAlester, Ind. T., and the right of way is now being secured with the intention of building the road next year, according to reports.

LOUISIANA.—It is reported that a committee has been appointed in Avoyelles Parish, La., to secure the construction of a railway through the towns of Evergreen, Cottonport, Moreauville and Bordelonville. The last named place is 25 miles northeast of Bunkie, on the Texas & Pacific, 162 miles from New Orleans. The committee will canvass the line to secure grants of right of way and will also consult with the officers of the Texas & Pacific and Southern Pacific railways. V. F. Gremithon, Chn. Com.

TEXAS.—The projected railway between Laredo, Tex., and Brownsville has been revived by Maj. John B. Armstrong and others, according to reports. Large subsidies of land and money would be granted by the lower border counties if the road should be constructed.

Rocky Mt. and Pacific—Existing Roads.

ASTORIA & PORTLAND.—It was stated several weeks ago that some 17 miles of this road southeast from Astoria, Ore., had been graded and that tracklaying was about to be commenced. It is now reported that the plans for the construction have failed and that the project may be abandoned.

ATLANTIC & PACIFIC.—It is announced that this road will be extended north through the San Joaquin Valley so as to give the Atchison, Topeka & Santa Fe R. R. a San Francisco terminus.

CANADIAN PACIFIC.—The Nakusp & Slocan Ry. has been surveyed from Nakusp, B. C., on Arrow Lake, to Slocan, on Lake Slocan, a distance of 21 miles, and the grading is progressing rapidly. The contractors are reported as under heavy bonds to have the road completed to the head of the lake this winter and to Three Forks, where it will connect with the Canadian Pacific, by May next.

EVERETT & MONTE CRISTO.—The ballasting of this road has been completed and the last gang of men paid off.

GREAT SALT LAKE & HOT SPRINGS.—At a recent meeting at Centerville, Utah, of the promoters of this railway, according to reports, it was decided to extend the line as far as Kaysville as soon as possible, which place would probably be the terminus for about a year. Gen. Man., S. Bamberger, Salt Lake City, Utah.

LOS ANGELES & PACIFIC.—This company has been reincorporated by John Cross and others, Los Angeles, and Chas. W. Cross, San Francisco; capital stock, $200,000. It is proposed to have the line between Los Angeles and Santa Monica, about 16 miles in length, in operation by next January.

Projects and Surveys.

CANADIAN RAILWAYS.—It is reported that application will be made to the Canadian Parliament for the incorporation of a company to build a railway from Regina, N. W. T., southerly or southwesterly to the international boundary line, near Wood Mountains; also a line from Regina northeasterly to the Saskatchewan River, east of the second meridian.—— Also to the legislature of British Columbia for a railway from the Gulf of Georgia, in Delta Municipality, to New Westminster, with a branch from some point in Delta eastward through Surrey, Langley and Matsqui, to Abbottsford.

CANYON CITY & CRIPPLE CREEK.—It is stated that negotiations are being made for constructing this proposed railway in Colorado. The company was incorporated a year ago by Eben Smith, Leadville; S. H. Hastings, Denver; L. D. Rondebush, Cripple Creek, and others.

OREGON.—The Portland "Oregonian" states that a surveying party has arrived at The Dalles after a seven weeks' trip through Eastern Oregon, the object being to find a feasible route for a railway from that place through the interior to the line of the Oregon Pacific in Lake county. The line surveyed was through Dechutes, up the Des Chutes River, thence to Prineville, in Crook county, and to the head of Silver Creek, 125 miles from Prineville, to the surveyed route of the Oregon Pacific. It is stated that the grade for the entire distance would be light and the construction not expensive. The territory is fertile and there are settlements nearly the whole distance of the proposed route. The projectors of the road are unknown.

STREET RAILWAYS.

EAST DOUGLAS, MASS.—Surveys have been completed for an electric railway from St. Charles Hotel, at Millbury, to East Douglas station. The route is through the center of the town and over Putnam Hill. A survey has also been made for a loop to start from Manchaug and run through West Sutton, joining the main line near the center. The work is being done under the direction of the Douglas town committee appointed last April.

HAVERHILL, MASS.—There is talk of an electric railway from this city through Plaistow, N. H., Atkinson, Hampstead, Chester and along the northerly shore of Lake Massabesic to Manchester. It is said that one town alone is ready to take $40,000 of the stock. A similar project was defeated in the New Hampshire legislature last winter.

BROOKLYN, N. Y.—The Brooklyn, Mapleton, Van Pelt Manor & Bath Beach Ry. Co. has been incorporated to construct a street railway in this city, from 39th St. and 2d Ave. to 19th St. and the water's edge of Gravesend Bay, in New Utrecht; capital stock, $100,000; Directors, Wm. P. Rae, Wm. Selleck, Daniel Kelly, E. L. Harriott, J. P. Puels and others.

LITTLE FALLS, N. J.—The electric railway is to be extended to the Greenwood Lake R. R. station at Singac.

WOODBURY, N. J.—The council has passed the much discussed trolley ordinance by a vote of 8 to 1. It provides that no exclusive franchise shall be granted and none for a longer term than 20 years. A tax of $25 per year will be levied on each car run within the city limits. It also provides that after five years the council may compel any company operating a road in the city to place its wires underground.

ALLEGHENY, PA.—The Ohio River & Chartiers Valley Electric Ry. Co. proposes to construct an electric railway from Sheriden and connect with Mansfield by way of Ingram, Crafton, Idlewood and Chartiers; capital stock, $150,000.

LANCASTER, PA.—Col. S. C. Slaymaker is making preliminary surveys for an electric railway from Neffsville to Mechanicsburg, which will connect with the one to New Holland, and for one from Neffsville to Ephrata, connecting with the Lancaster & Lititz Ry.

MARYSVILLE, PA.—It is reported that the proposed electric railway to Fairview is meeting with much favor. It would connect there with one to be built to Harrisburg.

PARKESBURG, PA.—Subscriptions are being made to secure a branch of the Philadelphia & Lancaster Electric Ry. from this place to Oxford. The distance is 13 miles and the right of way is about secured.

PITTSTON, PA.—The construction of the electric railway to Scranton has been commenced. When this is completed there will be a continuous electric line between Nanticoke and Carbondale, a distance of 43 miles.

BOONSBORO, MD.—The South Mountain Ry. & Electric Light & Power Co. has been incorporated to build an electric railway to Keedysville, a distance of three miles. The contract has been awarded to the Hughes & Rigby Engineering Co., Baltimore, and includes an electric light plant for both arc and incandescent lights. Pres., Geo. W. Jacobs, Jr., Philadelphia; Supt., Chas. J. Young, Boonsboro.

BRUNSWICK, MD.—It is reported that the proposed Middletown Valley Electric R. R. from Middletown to this city is looked upon with much favor by the capitalists interested in the road.

FREDERICK, MD.—The Catoctin Valley Electric R. R. & Power Co. has awarded the contract for an electric railway, 12 miles in length, from Middletown up the Middletown Valley by way of Myersville, to the Hughes & Rigby Engineering Co., Baltimore. This road is independent of the Frederick-Middletown electric line, but it will be run in connection with it, and freight and passengers will be sent through without change; Pres., Geo. W. Jacobs, Jr., Philadelphia; Supt., T. E. Bowne, New York; Treas., G. W. Wachtel, Myersdale.

WHEELING, W. VA.—In less than two months, according to reports, the tunneling of Reymann's Hill, opposite the head of 16th St., and the building of a double track electric railway through to Edgington, four miles distant, will be commenced. There are 1,000 acres of land now inaccessible at Edgington. The work is estimated to cost $400,000, of which $300,000 will come from Pittsburg.

LUDLOW, O.—Bids are reported as being received for constructing an electric railway in this place. J. C. Richardson, Cy. Clk.

PIQUA, O.—The Miami Valley Electric Ry. Co. is considering the construction of an electric railway between this city and Minster.

YOUNGSTOWN, O.—The surveys for the railway to Lauterman's Falls, noted in our issue of Sept. 21, show a maximum grade of 9%. Geo. McClure, Engr.

CHICAGO, ILL.—It is reported that an ordinance will soon be introduced in the council granting a franchise for an electric railway to Evanston. The line would be built from the Chicago River, the southern terminus being on Kinzie St., and extend to Evanston by the most feasible route, with at least two branches toward the northwestern suburbs of the city.

CARTHAGE, MO.—It is stated that two different parties are planning to build an electric railway from this city to Joplin. One proposes to stop at Carterville and there connect with the Rogers road to Joplin, while the other proposes a line from Carthage to Joplin paralleling the Rogers road from Webb City to that place.

ST. LOUIS, MO.—The St. Louis & Kirkwood R. R. Co., recently noted as incorporated, proposes to build an electric railway from this city through Benton, Webster and Kirkwood to Meramec Highlands, a distance of 10 miles. The right of way is being secured, but no contracts have yet been awarded. John Pitman, Laclede Building.

DALLAS, TEX.—Bids are being received for changing the motive power of the Dallas & Oak Cliff Ry., 17.5 miles long, from steam to electricity.

HAMILTON, ONT.—The H., G. & B. Electric Ry. Co. has been organized and is negotiating for a franchise. All but $12,000 of the proposed $100,000 of capital stock has been taken, according to reports; Pres., C. J. Myles; Secy., A. Rutherford.

ST. THOMAS, ONT.—The local press is urging the construction of the proposed electric railway to Port Stanley, connecting with adjacent villages.

HIGHWAYS.

MASSACHUSETTS.—The board of aldermen of Salem has appropriated $50,000 for the improvement of highways.

INDIANA.—The auditor of Tippecanoe county will receive bids until Oct. 11 for grading, graveling and all work, including bridges, culverts and gutters, necessary to construct a free gravel road in Fairfield township. J. W. Fewell, Engr., Lafayette.

MICHIGAN.—The citizens of Gogebic county have voted to adopt a county road system.

TEXAS.—The commissioners of Bexar county have decided in favor of an election to be held Oct. 11 to vote on an issue of bonds for $200,000 for road purposes.

BRIDGES.

NEW HAVEN, CONN.—The city is again considering the widening and straightening of West River, which was discontinued five years ago. The proposed work would require at least one new bridge, and it is very probable that two bridges on Kimberly Ave. on the approach to West Haven would either be raised or replaced by drawbridges. Plans are now being prepared for the work.

ALLEGHENY, PA.—Residents of this city and Sheriden are petitioning for a bridge across the Ohio River to connect the two cities. The bridge would be used by the proposed Ohio River & Chartiers Valley and two other electric railway companies, and is estimated to cost $300,000.

ATHENS, GA.—The street commission has been authorized to advertise for bids for a bridge over the Oconee River, near the check factory.

KANSAS CITY, KAN.—The county commissioners have awarded the contract for a bridge across the Kaw River, at Bonner Springs, to the St. Joseph Bridge & Iron Works, at $15,400. The other bids are reported as follows: Koker Iron Works, $23,100; Jamestown Bridge Co., $20,000; Wrought Iron Bridge Co., $18,475, John Dilding & Co., $18,700; Geo. E. King Bridge Co., $15,434; Canton Bridge Co., $18,590; Chicago Bridge & Iron Co., $15,950; Massillon Bridge Co., $19,689.

NEWTON, TEX.—R. P. Wingate, Co. Comr., is circulating a petition to the commissioners' court to change a portion of the Newton and Orange road and to build a bridge across Cypress Bayou, in the south and of the county, where the new road would cross the bayou. The bridge would be 480 ft. long.

OTTAWA, ONT.—The contract for the steel superstructure of the railway bridge across the Sault Ste. Marie Canal has been awarded by the department of railways and canals to the Hamilton Bridge Co., at about $25,000.

WATER-WORKS.

BANGOR, ME.—It is stated that the city is in need of a new pump.

EXETER, N. H.—The question of municipal works will be voted on next March.

MANCHESTER, N. H.—The contract for a pumping station, etc., has been awarded to the Head & Dowst Co., Manchester, at $8,361.

ENOSBURG FALLS, VT.—The contract for works has been awarded to Lang & Goodhue, Burlington, and the construction commenced.

CHESTER, MASS.—The committee on works has reorganized; Chn., Timothy Keefe; Secy., C. W. Smith.

GREENFIELD, MASS.—The commissioners are selecting a site for an additional storage reservoir.

LYNN, MASS.—The aldermen have voted to take Sagus River water for the city, under the recent legislative act.

NEWBURYPORT, MASS.—About 20 test wells will be sunk by Percy M. Blake, the engineer of proposed municipal works.

NORTHAMPTON, MASS.—Four plans are being considered for enlarging the reservoir capacity: A dam above present reservoir with a capacity of 82,000,000 gallons; dam, capacity 110,000,000 gallons; raise upper dam 10 ft., giving additional capacity of 21,000,000 gallons; reservoir on Day Brook, capacity 60,000,000 gallons.

SALEM, MASS.—The council has appropriated $19,000 for a 6-in. main in Canal St., the work to be done at once; also $2,000 for extensions in other streets.

SPRINGFIELD, MASS.—Surveys are being made for a new reservoir in the southern part of Pelham. The dam will be 300 ft. long and 27 ft. high, according to reports, and the reservoir will have a capacity of 300,000,000 gallons.

BRISTOL, R. I.—The committee appointed last March finds that the only remedy for exorbitant rates is municipal works.

NEW LONDON, CONN.—W. W. Richards, Supt., is preparing a report on an additional supply. Several plans are proposed, the estimates ranging from $27,250 to $150,000, according to quantity and source of supply.

FREEPORT, N. Y.—The citizens have voted in favor of works.

KINGSTON, N. Y.—The recent vote on the issue of bonds for works was 1,036 in favor and 403 against the proposition.

NEW YORK, N. Y.—The department of charities will receive bids until Oct. 10 for works at Central Islip, Long Island.

SUFFERN, N. Y.—The works of the Mountain Spring Water Co., supplying Suffern, Hillburn and other places, have been completed and tested. Pres., W. W. Snow; Engr., W. C. Foster.

NEWARK, N. J.—The board of public works has adopted plans for a 235,000,000-gallon storage reservoir at South Orange, estimated to cost $800,000. Engr., Charles E. A. Jacobsen; Consult. Engr., A. Fteley.

HOWARD, PA.—The contract for works has been awarded to the Logan Machine Works, Bethlehem. The work includes about 15,000 ft. of pipe, and a reservoir to be constructed about a mile distant.

JENKINTOWN, PA.—Land has been purchased for a pumping station.

LEHIGHTON, PA.—The Weissport Water Co. has been incorporated; capital stock, $5,000.

LOCK HAVEN, PA.—The contract for the new supply has been awarded to Joseph Candor & Co.. at $24,093 for pipe and $8,942 for pipelaying. The other lowest totals were as follows: Geo. S. Good & Co., $24,316 and $9,963, respectively; D. K. Miller, $26,151 and $8,495; Miller, Mussina & Co., $27,528 and $8,495. The bidders named are residents of this city.

POTTSVILLE, PA.—The Morea Water Co. has been incorporated by E. L. Bullock, F. C. Stout and C. M. Dodson, all of Bethlehem; capital stock, $5,000.

LONACONING, MD.—John Pownall has reported on a supply from the Midland Run; estimated cost, $29,000. An election was held Oct. 3 to vote on an issue of bonds for $30,000 for works.

MANNINGTON, W. VA.—We are informed that the Mannington Water Supply Co. built works here about two years ago, and that the recent vote to issue bonds was for purchasing the works.

COLUMBIA, S. C.—J. A. Felner, Supt., has recommended that an additional supply be secured from springs on Rocky Branch, according to reports.

YORKVILLE, S. C.—The contract for works has been awarded to Thornwell McMaster, Columbia.

COLUMBUS, GA.—B. M. Hall, Atlanta, has reported in favor of a supply from creeks; estimated cost, $120,000.

GRIFFIN, GA.—The Griffin Water Works Co. is purchasing 50 tons of 6-in. pipe for proposed extensions.

HUMBOLDT, TENN.—An election will be held Oct. 24 to vote on awarding a franchise for 25 years to a Memphis firm for works.

CLOVERPORT, KY.—The question of works is reported as being discussed

COLUMBUS, O.—The department will receive bids for increasing the supply. Three test wells have been completed.——It is reported that the use of meters will be introduced next month.

MASSILLON, O.—The company reported last week is a reorganization of the Massillon Water Co. E. L. and F. W. Arnold, F. H. Killinger, A. W. Inman, of this city, and C. W. Paine, of Cleveland, are the incorporators.

NORTH BALTIMORE, O.—The plant of the North Baltimore Water Co. will be sold at auction Oct. 24. It has been appraised at $45,000.

NORWOOD, O.—Over 30 bids were received for furnishing and laying about 75,000 ft. of pipe, recently noted in these columns, the contract being awarded to Herbert & Lopeyer, Chattanooga, Tenn., at $47,313. It includes 1,400 tons of pipe, to be furnished by the Addyston Pipe & Steel Co., and 215 fire hydrants, to be furnished by the Bourbon Copper & Brass Works, and specifies also that only local labor shall be employed.

PLAIN CITY, O.—Bids are asked until Oct. 20 for works and an electric light plant; also for $30,000 of 6% bonds. G. E. Kilbury, Clk.

PORTSMOUTH, O.—The contract for a new pumping engine has been awarded to the Laidlaw-Dunn-Gordon Co., at $19,300.

SANDUSKY, O.—The committee has recommended an appropriation of $10,000 for new mains.

YOUNGSTOWN, O.—The committee has decided to submit the question of bonds for proposed works to a vote of the people.

LOGANSPORT, IND.—The engineer has recommended improvements to cost $20,000, including a new pump.

MARION, IND.—Bids are asked until Oct. 9 for a new pump and boiler.

BELDING, MICH.—The contract for works has been awarded to the Michigan Pipe Co., Bay City.

GRAND RAPIDS, MICH.—It is reported that the committee has sold $1,225,000 of 20-year 4½% bonds to R. L. Day & Co., Boston.

HOWELL, MICH.—Bids are asked until Oct. 12 for works. L. C. Smith, Secy. Bd.

ST. ANNE, ILL.—Jas. Porch, Chebanse, has offered to put in works to cost about $7,500 and to accept bonds in payment.

MILWAUKEE, WIS.—The bond ordinance recommended to the council for passage includes $125,000 for water-works.

DULUTH, MINN.—The council has voted in favor of an election Nov. 7 to vote on an issue of bonds for $400,000 for municipal works.

ST. PAUL, MINN.—The park board has awarded the contract for 1,900 ft. of 8-in. and about 5,500 ft. of 4-in. pipe for Como Park to the Robinson-Cary Co. The pipe will be laid this fall and a 50,000-gallon tank will be built in the spring.

OMAHA, NEB.—The council has voted to submit a proposition to the citizens authorizing the issue of bonds for $1,500,000 for the purchase of water-works or the construction of a water supply canal.

LARAMIE, WYO.—We are informed that bonds for $100,000 are being advertised for works. The supply would be pumped from the Laramie River to a standpipe; population, 6,400; Geo. Berner, Chn. Com.

DALLAS, TEX.—The city engineer is making surveys for an additional supply.

OAK CLIFF, TEX.—It is reported probable that extensions will soon be made.

GRAND JUNCTION, COLO.—The council is considering an ordinance granting a franchise to the Western Colorado Development Co. for an artesian supply.

SOUTH DENVER, COLO.—The committee has recommended that the town provide its own supply. The works were built by the town but are now operated by a private company.

WENATCHEE, WASH.—W. R. Prowell, Tn. Clk., writes us that the city intended to issue bonds for works but that nothing is now being done. The supply would be pumped from the Columbia River to a reservoir; estimated cost, $12,000.

MONTREAL, QUE.—The committee has recommended the purchase of a 10,000,000-gallon pumping engine. The superintendent has recommended improvements to cost $116,000, including new engine, engine house, repairing reservoirs and present engine. A tunnel in Atwater Ave. to cost $350,000 is also reported as becoming a necessity.

HAMILTON, ONT.—The committee is considering the adoption of meters.

ARTESIAN WELLS.

CHIPLEY, FLA.—The citizens are reported as considering plans for an artesian well.

SEWERS.

HOLYOKE, MASS.—It is thought probable that bids will soon be received for the Elmwood trunk sewer. The city is negotiating for the sale of sewer bonds for $100,000.

LAWRENCE, MASS.—The aldermen have voted a 10-year loan of $50,000 for sewers.

LOWELL, MASS.—The council has voted a loan of $20,000 for the proposed Centralville sewer.

NEW BEDFORD, MASS.—The council has appropriated $6,700 for a 12-in. pipe sewer in Davis St.

PROVIDENCE, R. I.—Bids are asked until Oct. 9 for 12 to 20-in. pipe and brick sewers, seven contracts. Robt. E. Smith, Comr.

BUFFALO, N. Y.—The department of public works will receive bids until Oct. 13 for five 10 to 15-in. tile sewers.

EAST ORANGE, N. J.—A committee has been appointed to consider the advisability, cost, etc., of building an outlet sewer to the Passaic River.

ENGLEWOOD, N. J.—The Englewood Sewerage Co. declined to accept the offer of land for a sewage disposal plant, noted some Weeks ago. It is now claimed that the outlet causes a nuisance which it will require about two miles of additional sewer to abate.

JERSEY CITY, N. J.—The board of finance has decided to build a sewer to drain the northern part of the city; estimated cost, $85,000.

MERIDIAN, MISS.—An election will probably be held early next month to vote on the proposed construcion of a system; estimated cost, $95,000; Consult. Engr., Samuel M. Gray, Providence.

AURORA, ILL.—Assessments have been confirmed for over 50 miles of sewers and other improvements, estimated to cost $410,000. The work will be advertised early next spring. M. G. Stolp, Cy. Engr.

MARINETTE, WIS.—The city has sold $50,000 of sewer bonds, at 92¼ cts., to O. G. Kringle, who has the contract for sewers.

GREAT FALLS, MONT.—Bids are asked until Oct. 10 for a sewer in Third St. C. H. Clark, Cy. Clk.

OAKLAND, CAL.—Plans for a sewage disposal plant for the drainage from the county infirmary buildings have been prepared by Mr. Nusbaumer, Co. Surv.; estimated cost, $15,000.

SACRAMENTO, CAL.—The committee has recommended that an engineer be employed to prepare a topographical map of the city and plans for a system.

SAN FRANCISCO, CAL.—The city and county surveyor has reported that the proposed Presidio sewer, which is to traverse the government reservation and drain the heights above, will be 2,400 ft. long, with a fall of 60 ft., and that 1,500 ft. will be in tunnel; estimated cost, $20,000.

SAN LEANDRO, CAL.—The citizens have voted, 278 to 20, in favor of an outlet sewer to the bay; estimated cost, $18,000.

GUELPH, ONT.—The board of trade is negotiating with the Lewis-Mercer Construction Co., New York, for a system.

OTTAWA, ONT.—The board of works has reported in favor of an election to vote on a sewer for the southern and southwestern part of the city; estimated to cost, $165,000.

WINNIPEG, MAN.—Bids are asked until Oct. 12 for two sewers. G. H. West, Chn. Com.

STREETS.

NEW BRUNSWICK, N. J.—Bids are asked until Oct. 16 for grading Sicard St. R. R. Hagerman, St. Comr.

DEFIANCE, O.—The lowest bids for improving Perry & Deatrick Sts. were those of T. S. Wright, Defiance, aggregating $35,240. H. S. Hallwood bid $40,219.

VAN WERT, O.—Bids are asked until Oct. 12 for macadamizing Water St., and until Oct. 13 for 4,900 lin. ft. of curbing. C. F. Manship, Clk.

WINTON PLACE, O—Bids are asked until Oct. 16 for artificial stone sidewalks. R. B. Poage, Vil. Clk.

BRAZIL, IND.—Bids are asked until Oct. 17 for brick sidewalks. John McDonald, Cy. Clk.

AURORA, ILL.—Bids will be asked early next spring for paving with brick and cedar blocks. M. G. Stolp, Cy. Engr.

WEST DULUTH, MINN.—The lowest bid for improving State St. was that of E. F. Mitchell, at $24,000. The contracts for improving Elinor and Highland Sts. have been awarded to P. R. McDonnell, and those for Third St. south and one alley to J. T. Dixon.

URBANA, IA.—The council has voted to pave two additional blocks on Race St.

ELECTRIC LIGHT AND POWER.

SMYRNA, MD.—The contract for an electric light plant has been awarded to Charles E. White, Philadelphia, at $9,431, including building. The specifications provide for one 75-HP. single cylinder, automatic cut off Ames engine; one dynamo, 30 K-W., 1,000 volts compound-wound alternating current, to be run from each circuit; 200 incandescent lamps, 16 c. p.; 50 incandescent lamps, 32 c. p.; 21 Helios arc lamps, 10 ampere current for streets, to burn all night. There will be two separate circuits, one for street lighting and one for commercial lighting.

MADISONVILLE, O.—Bids are asked until Oct. 22 for $15,000 of 20-year 5% electric light bonds. Bennet Carter, Vil. Clk.

PLAIN CITY, O.—Bids are asked until Oct. 20 for an electric light plant. G. E. Kilbury, Clk.

CHATSWORTH, ILL.—An electric light plant will be put in by C. C. McDonald, according to reports.

TOPEKA, KAN.—The Chicago-Topeka Light, Heat & Power Co. will receive bids until Oct. 18 for a water power and electric plant on the Kansas River, as stated in our advertising columns. Pres., E. C. Gibson, Rookery Building, Chicago.

BRANTFORD, ONT.—The contract for lighting the city for five years has been awarded to the Brantford Electric Light & Power Co., at 23 cts. per light per night. The committee reported in favor of a contract for one year with a view to securing a municipal plant, but the report was not accepted.

NEW COMPANIES.—Domestic Electric Light & Power Co., Baltimore, Md.; $50,000; Samuel Kimberly, Norfolk, Va.; J. H. T. Jerome, A. B. Howard, Jr., and others, Baltimore.——C. C. Warren Electric Co., Chicago, Ill.; $200,000; H. B. Warren, W. W. Wheelock, G. B. Shattuck.

CONTRACT PRICES.

BRICK PAVING.—New Orleans, La.—Bids for paving with vitrified brick ranged from $2.98 to $3.60 per sq. yd. Bids for brick sidewalks were received at $1.29 per sq. yd., and $1.32 per cu. yd. for filling.

DREDGING.—Mobile, Ala.—The following bids were ceived by Maj. A. N. Damrell, U. S. Engineer Office, for dredging in the Mobile River: San Francisco Bridge Co., 17 cts. per cu. yd.; Alabama Dredging & Jetty Co., 16.5 cts.

EXCAVATING.—Boston, Mass.—The water board received the following bids for excavating and disposing of 16,000 cu. yds. of stripping in basin 6, now nearing completion: Auguste Saucier, 34½ cts. per cu. yd.; Thos. F. Maney & Co., 42½ cts.; Newell & Snowling, 48 cts.; Neil McBride, 60 cts.; J. W. Bowers, 83 cts., and Robt. A. Davis, 79 cts.

LEVEE WORK.—New Orleans, La.—The Lafourche Levee Board has awarded contracts at the following prices: C. D. Leeper, 11.97 to 13.3 cts. per cu. yd.; J. A. Carson, 14.5 cts.; Leche & Byrnes, 14.74 cts.; P. J. Tyrrell, 14.99 cts.; John Cleary, 15.5 and 16.5 cts.; Martin Head, 14.25 cts.; Donovan & Daly, 13.4 cts.; J. M. Sullivan, 14 and 15.24 cts.; Andrews Bros.' Const. Co., 16.5 cts.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

DRAINAGE CANAL.—Chicago, Ill.—Bids will be received until Nov. 29 for excavating five miles of the drainage canal. Thos. F. Judge, Clk., Rialto Bldg.

SCHOOL BUILDING.—Madison, Wis.—Bids are asked until Oct. 20 for the erection of a normal school building at Stevens Point. W. D. Parker, Secy. Bd.

STATION HOUSE.—Cincinnati, O.—Bids will soon be asked for constructing the York St. station house. It will be built of brick and contain 16 cells; estimated cost, $25,000.

GAS PUMPING STATION.—Toledo, O.—The gas trustees have awarded the contract for building the new pumping station in the field to the Toledo Supply Co., at $12,306.

RIVER WALL.—Grand Rapids, Wis.—The council has voted to erect a river wall along the Wisconsin River front. It will be about one-eighth of a mile long, 14 ft. high and 6 to 8 ft. thick.

BUILDING PLANS.—Houston, Tex.—Architects are requested to submit plans until Dec. 1 for a $75,000 high school building. The sum of $1,500 will be paid for the plans accepted. John T. Browne, Mayor.

GASOLINE LIGHTING.—Omaha, Neb.—The comptroller will receive bids until Oct. 10 for lighting the suburbs of the city with gasoline lamps of 16-c. p. for two years from Jan. 29, 1894. The present price is $18.75 per light per year.

IRON WORK, ETC.—San Bernardino, Cal.—Bids are asked until Oct. 16 for the masonry and iron work, gas fitting and steam heating work, electrical work, etc., for a building for the state asylum for the insane. H. L. Drew, Chn. Bd.

IRON RAILINGS, ETC.—New York, N. Y.—Bids will be received at the office of the city comptroller until Oct. 10 for iron railings, snow guards, window guards, panel partitions, balconies, stairs, gates, etc., for the new criminal court house, on the block bounded by Centre, Elm, Franklin and White Sts.

STEAM PLANT, ETC.—New York, N. Y.—The department of public charities will receive bids until Oct. 10 for a steam plant and conduits at Central Islip, Long Island; also for system of water-works and drainage at same place, and for repairs, etc., to branch asylum, Wards Island.

WHARF.—Washington, D. C.—Bids will be received at the office of public buildings and grounds until Oct. 30 for a wharf of cast iron screw piles with a timber deck, near the mouth of Bridge Creek, Va. The deck will be 1,050 ft. long by 16 ft. wide, the head to be 40 ft. by 60 ft.; sum available, $10,000. Col. John M. Wilson, U. S. A.

Great Neck, N. Y.—M. H. Gregory has applied to the trustees of North Hempstead for a grant of land under water in Manhasset Bay for the erection of a dock 400 ft. long with a 50 ft. bulkhead.

INDUSTRIAL NOTES.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, has delivered two compound engines, of an order for 12, to the Missouri, Kansas & Texas Ry. They have six 6-ft. driving wheels, and are intended for fast passenger service.

THE GILBERT CAR MFG. CO., Troy, N. Y., shipped 20 cars for the Lake St. elevated railway, Chicago, this week. The remaining 50 of 100 ordered will be built as soon as satisfactory arrangements can be made for the reorganization of the company.

THE WESTINGHOUSE AIR-BRAKE CO., Pittsburg, Pa., is having plans prepared for an addition to its plant at Wilmerding, Pa., which will cost $80,000 to $100,000.

THE SAFETY CAR HEATING & LIGHTING CO., New York, has received the contract for equipping all the passenger cars of the Missouri, Kansas & Texas Ry. with steam heating apparatus.

JAMES STEWART & CO., Buffalo and St. Louis, have been awarded the contract for the power-house for the Cataract Construction Co., at Niagara Falls, N. Y. The building will be of Queenston limestone, lined inside with glazed brick, have slate roof and iron columns, and be 66 × 200 ft. with a height of 60 ft. It will be fitted with 10 turbine wheels having a capacity of 50,000 HP.

JOSEPH G. FALCON, Evanston, Ill., has completed the 1,500-ft. water-works intake pipe at Ft. Sheridan, Ill., on which are 30 12-in. Falcon joints, and it recently stood a pressure, under an official test, of 82 lbs. Capt. F. B. Jones, Asst. Q. M., U. S. A., was the engineer in charge. Mr. Falcon is at present putting in a 2,000-ft. intake on which there will be 40 16-in. Falcon joints, at Highland Park, Ill. Engr., W. S. Shields, Chicago.

THE SPRINGFIELD BOILER & MFG. CO., Springfield, Ill., has been awarded the contract for constructing 15 lengths of floating pipe, 32 ft. long, for use in constructing levees along the Mississippi River. They are 30 ins. in diameter, with air chambers on top to be 6 ft. wide. This company is now constructing a water-works stand-pipe, 18 × 120 ft., at Independence, Mo., Engr., Chas. Ledlie, St. Louis, and it has recently completed a stand-pipe for the Neenah, Wis., water-works, 20 × 115 ft., Engr., Geo. W. Sturtevant, Jr., Chicago.

THE SECKNER CONTRACTING CO., Unity Bldg., Chicago, has recently been awarded contracts as follows: For completing Harlem, Ill., water-works, including 12 miles of 16 to 4-in. pipe, 111 Eddy hydrants, 52 Eddy valves; Geo. C. Morgan, Engr.; laying 4 miles of water pipe and setting 25 hydrants at West Pullman, Ill.; grain elevators, including plans, one at 46th St. and Wabash R. R. tracks, for Frank Marshall, and one on Wentworth Ave., for F. A. Walthers. The company is also erecting a bridge at Havana, Ill., iron work furnished by the King Bridge Co., Cleveland, 850 tons, and is interested in the erection of the new Stock Exchange Building, Chicago.

THE MASON REGULATOR CO., Boston, has recently manufactured several Mason vacuum valves for a large Canadian sugar refinery, which are a novelty in the way of a regulating device. They are to the regulation of a vacuum what the reducing valve is to steam pressure, for by placing one of these valves in the exhaust pipe leading to the vacuum pump any desired amount of vacuum may be kept in the chamber by simply adjusting the valve. Such a valve is especially desirable where different degrees of vacuum are desired in each one of a series of chambers, as in the triple effect process of sugar refining and other processes where a certain vacuum is desirable.

THE LINK-BELT MACHINERY CO., Chicago, reports business as rapidly picking up, with an increased demand for its labor-saving devices among the diversified industries of the country. It has just designed and erected for the J. T. Staff Packing Co.'s new canning factory, at Cayuga, Ind., a box conveyor, 150 ft. long and 11 ft. wide, which the Link-Belt Co. has very appropriately christened a "Merry-Go-Round." An empty can conveyor and a slop conveyor, the whole being driven by a manilla rope power transmission, was also furnished to this company. A system of coal and ash handling machinery has been furnished to the rail mill boiler room of the Illinois Steel Co., at South Chicago, and a similar outfit at the steel mill boiler room, at Joliet, for the same company. An inclined conveyor for handling sides of beef, 52 ft. long, driven by a manilla rope power transmission, has also been furnished Armour & Co., Chicago.

NEW COMPANIES.—Engineering Improvement Co., Chicago, Ill.; $100,000; Ezra T. Williams, B. A. Thomas, T. H. Williams.——U. S. Repair & Guaranty Co., Chicago, Ill.; $200,000; V. W. Foster, A. H. Perkins, Adam Thompson.——Werser & Cramer Brick & Tile Co., Clifton, Ill.; $11,000; W. W. Werser, B. M. Werser, W. H. Cramer.——C. C. Warren Electric Co., Chicago, Ill.; $200,000; to construct steam railways and electric light plants; H. B. Warren, W. W. Wheelock, G. B. Shattuck.——Tousley Trolley Co., Chicago, Ill.; $100,000; to manufacture trolley wheels; J. J. Zoller, W. F. Stone, F. R. Smith.

The Correspondence School of Mechanics, Scranton, Pa.

Question. What is the Correspondence School of Mechanics?

Answer. It is an educational institution intended to meet the wants of Machinists, Mechanics, Locomotive, Stationary and Marine Engineers, Firemen and others interested in Mechanical pursuits who cannot afford to quit work to attend the regular technical schools in order to obtain the education which they need. It teaches Mechanical Drawing and the theory of Mechanics by Correspondence.

Ques. What are the branches taught?

Ans. Arithmetic, Algebra, Geometry, Trigonometry, Elementary Mechanics, Hydromechanics, Pneumatics, Heat, Mechanical Drawing, Steam and the Steam Engine, Strength of Materials, Applied Mechanics, Boilers, Machine Design, Electricity and everything included in a Complete Mechanical Engineering education.

Ques. Are all these branches taught by mail?

Ans. Yes. There are now over 600 students studying in this School who are making good progress.

Ques. What qualifications are required to enroll as a student, and when can students commence?

Ans. The only qualification necessary is to know how to read and write; students can begin at any time.

Ques. How is instruction given by mail?

Ans. In place of the text-books of the regular schools the students receive carefully prepared and liberally illustrated Instruction Papers and Mechanical Drawing Plates covering all the subjects embraced in the Complete Course. These are accompanied by Question Papers containing questions upon the subjects treated of and problems based upon the principles explained. The student studies the first Instruction Paper and writes the answers to the questions and problems in the accompanying Question Paper and sends his work back to the School. This work is carefully examined by competent Instructors, and if errors have been made, the necessary help is given, and it is returned to be done over. The student is furnished with blanks with which to write for an explanation of anything in the Instruction Paper he may not understand. The student is kept studying each Instruction Paper until he has a thorough knowledge of the subject treated of, when he receives a passing mark on the Records of the School and is advanced to the next Instruction Paper.

Ques. Is it possible to teach Mechanical Drawing by mail?

Ans. Yes. The information given is full and clear, the exercises are practical and instructive, and the drawings furnished to be copied are worked out in detail. Persons who will apply themselves can learn not only to draw, but to design Machinery.

Ques. What advantage has this method of study over that of the regular schools?

Ans. An education is procured without leaving home or losing time from work. The student can take his own time to study. He has his teacher always at hand. He can advance according to his ability and time without reference to other students. Should sickness prevent him from studying he does not lose standing. The cost of the Scholarship is less than tuition in other schools. The best way to remember a thing is to write it down.

Ques. What are the Scholarships?

Ans. The branches taught are divided into two so-called Scholarships: the Complete and the Mechanical Drawing Scholarships. Holders of the Complete Scholarship are entitled to instruction in all the branches taught in the School. The Mechanical Drawing Scholarship includes the first nine branches mentioned above.

Ques. What are the prices of Scholarships?

Ans. The Complete Scholarship costs $35 in advance, or $40 in installments. The Mechanical Drawing Scholarship costs $25 in advance, or $30 in installments.

Ques. How are the installments paid?

Ans. Ten dollars with the application for admission and the balance in monthly installments of $5 each.

Ques. If a student is unable to pay his installments promptly does he lose his Scholarship and the money he has paid?

Ans. No. If on account of sickness or any reasonable cause a student is unable to pay promptly the time of payment is extended.

Ques. What are the expenses connected with the course?

Ans. Only those of postage, stationery and that of instruments and material to do the Mechanical Drawing work. By an arrangement with the Technical Supply Company, of Scranton, we are able to furnish students with these at very reasonable prices.

Ques. Are students required to purchase text-books?

Ans. No. The Instruction Papers form a complete text-book and are all that are necessary.

Ques. Are diplomas given to students completing the Course?

Ans. The graduate receives a Diploma stating that he has completed the course of study embraced in his Scholarship and that he has successfully passed an examination in all the branches.

Ques. For whom is this School intended?

Ans. Machinists, Mechanics, Draftsmen, Engineers, Firemen and all connected with the Mechanical industries who are anxious to advance. It is an opportunity for them to obtain a technical education necessary to secure better positions and better pay. It is the only way to get an education without leaving home or quitting work.

Ques. Does it require a long time to complete the course of study?

Ans. No. The Instruction Papers are carefully and concisely written by competent Mechanical Engineers. Everything unimportant is omitted, and only that retained which is necessary to make clear to the student what he must know. The course is as short as is consistent with thoroughness.

The Complete Course requires, for those who can only devote a few hours after work to study, about 18 months; the Mechanical Drawing about 9 months.

Ques. How can I obtain more information about the School?

Ans. By writing to The Correspondence School of Mechanics, Scranton, Pa., they will gladly send you a free Circular of Information which contains all particulars of the Course of Study, Method of Instruction, Terms, etc.

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King Bridge Co.... 27
Knowles Steam Pump Works.. 33
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Laidlaw-Dunn-Gordon Co.... 32
Lake Shore Foundry.... 35
Lancaster James H.... 25
Landreth, Olin H.... 2
Lang & Goodnue Mfg. Co.... 33
Lawrence Cement Co.... 29
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Lesley & Trinkle.... 16, 36
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Lidgerwood Mfg. Co.... 4, 25
Link Belt Machinery Co.... 4
Livengood, W. C.... 24
Locke, A. W. & F. B.... 8
Lookout Sewer Pipe Co.... 31
Loss & Co., C. E.... 1
Lowrth, Chas. P.... 3
Ludlow Valve Mfg. Co.... 15
Luclus, Albert.... 3

Mahn & Co.... 14
Mairs & Lewis.... 14
Malbouhan, M.... 3
Males & Co., A. S.... 6
Marion Steam Shovel Co.... 25
Martino, C. P.... 33
Maslin & Son.... 33
Mason, W. P.... 3
McConway & Torley Co.... 5
McLean, John.... 18
McLeod, John.... 2
McNeal Pipe & Fdry. Co.... 35
Massillon Bridge Co.... 28
Meacham & Wright.... 13
Meller Fdry. & Mach. Co.... 35
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Michigan Brass & Iron Works.. 15
Michigan Pipe Co.... 35
Middleton, W. S.... 22
Miles, Franklin S.... 5
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Modjeski, & Nickerson.... 3
Moore & White Co.... 4
Morse & Son, A. J.... 12
Mosler Safety Signal Co.... 1
Mundt & Sons.... 1
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National Machinery Co.... 11
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N. Y. & Bermudez Co.... 10, 19
N. Y. & Rosendale Cement Co.. 36
N. Y. Exhaust & Blowpipe Co. 34
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N. Y. Mastic Works.... 13
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Ohio Paving Co.... 31
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Osborne & Son, R. B.... 10
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Page Woven Wire Fence Co.... 12
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Pancoast & Rogers.... 33
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Park Fire Clay Co.... 1
Passaic Rolling Mill Co.... 28
Patterson, M. D.... 3
Pelton Water Wheel Co.... 32
Pencoyd Bridge & Const'n Co.. 27
Pencoyd Iron Works.... 27
Penn Bridge Co.... 27
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Pennsylvania Steel Co.... 37, 39
Peet Valve Co.... 15
Pfister, Herm.... 14
Philadelphia Engineering Wks 4
Phillips, Hiram.... 3
Phœnix Bridge Co.... 26
Phosphor-Bronze Smelting Co. 51
Pierce & Miller Engin'ring Co.. 11
Pittsburg Bridge Co.... 37
Pittsburg Locomo. & Car Wks. 6
Pittsburg Reduction Co.... 16
Pittsb'g Test Laborat'y, Ltd.. 2
Platt, Jos. C.... 2
Poole, Robt. & Son Co.... 4
Pope, R. C.... 11
Porter, H. K. & Co.... 6
Potter, Alexander.... 3
Pottsville Iron & Steel Co.... 28
Power, J. Clyde, & Co.... 3
Prentiss & Slocum.... 1
Prosser & Son, Thomas.... 6
Pulsometer Steam Pump Co., l, 33
Purdue University.... 30

Radford Pipe & Foundry Co.. 35
Ramapo Iron Works.... 12
Rand Drill Co.... 5
Randolph, T. F.... 28
Raymond, W. G.... 3
Reed & Co., W. S.... 12
Remington & Co.... 3
Rendrock Powder Co.... 5
Rensselaer Mfg. Co.... 14
Rensselaer Polytechnic Inst.... 30
Rice, Geo. S.... 3
Ricker & Wing.... 3
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Riehle Bros.' Testing Mach. Co. 7
Ripley, H. G.... 3
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Rowe & Rowe.... 3
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Safety Car H'ting & L'ting Co.. 7
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Sargent Co.... 6
Schrader & Son.... 12
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Schwenke, Kirk & Co.... 30
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Sparks & Evans.... 13
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Stanwix Engineering Co.... 3
Staten Island T. C. Lumber Co. 31
Stearns Bros.... 5
Stearns Mfg Co.... 30
Stebbins, W. L.... 1
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Stillwell-Bierce & Smith-Vaile Co.... 32
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Stow Mfg. Co.... 22
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Tamaqua Mfg Co.... 13
Taylor Jas. T & Co.... 3
Thacher & Breymann.... 12
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Thomson Meter Co.... 8
Thomas, T. Kennard.... 3
Toledo Bridge Co.... 28
Toledo F'dry & Machine Co.... 25
Tomkins, Calvin.... 15
Trenton Iron Co.... 6
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Waring, Jr., Geo. E.... 3
Warren Chemical & Mfg. Co.... 16
Warren F'dy & Machine Co.... 35
Warren Scharf Asph't P'v'g Co 38
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Western Cement Co.... 13
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Westinghouse Air Brake Co.... 29
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White, Wm. Henry.... 3
Wiley & Sons, John.... 18
Wilkins & Davidson.... 3
Wilson Brothers & Co.... 3
Wise & Watson.... 3
Woltmann, Keith & Co.... 3
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Wrought Iron Bridge Co.... 27
Wuerpel Switch & Signal Co.... 1

Yeats & Gibson.... 3
Young & Sons.... 14
Youngstown Bridge Co.... 27
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